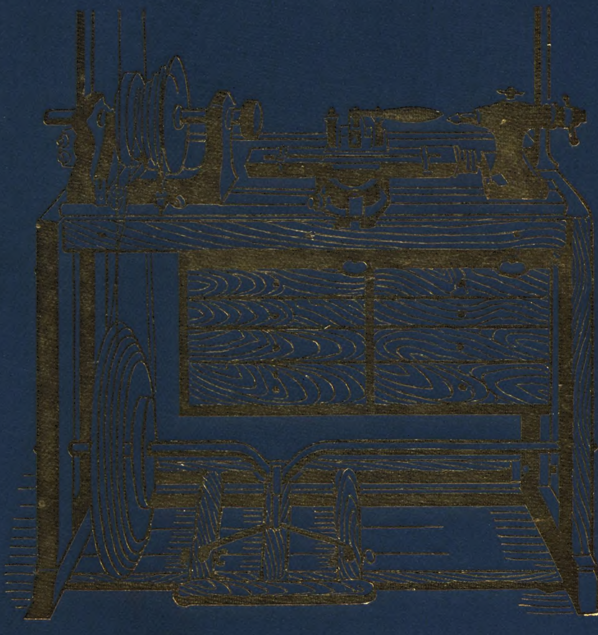
ORNAMENTAL TURNING

VOL. 2



J·H·EVANS

HANDICRAFT SERIES.

A Series of Practical Manuals.

Edited by PAUL N. HASLUCK, Editor of "Work," "Technical Instruction Series," etc.

Price 50 cts. each, postpaid.

House Decoration. Comprising WHITEWASHING, PAPERHANGING, PAINTING, etc. With 79 Engravings and Diagrams.

Contents.—Colour and Paints. Pigments, Oils, Driers, Varnishes, etc. Tools used by Painters. How to Mix Oil Paints. Distemper or Tempera Painting. Whitewashing and Decorating a Ceiling. Painting a Room. Papering a Room. Embellishment of Walls and Ceilings.

Boot Making and Mending. Including REPAIRING, LASTING, and FINISHING. With 179 Engravings and Diagrams.

Contents.—Repairing Heels and Half-Soling. Patching Boots and Shoes. Re-Welting and Re-Soling. Boot Making. Lasting the Upper. Sewing and Stitching. Making the Heel. Knifing and Finishing. Making Riveted Boots and Shoes.

How to Write Signs, Tickets, and Posters. With 170 Engravings and Diagrams.

Contents.—The Formation of Letters, Stops, and Numerals. The Signwriter's Outfit. Making Signboards and Laying Ground Colours. The Simpler Forms of Lettering. Shaded and Fancy Lettering. Painting a Signboard. Ticket-Writing. Poster-Painting. Lettering with Gold, etc.

Wood Finishing. Comprising STAINING, VARNISHING, and POLISHING. With Engravings and Diagrams.

Contents.—Processes of Finishing Wood. Processes of Staining Wood. French Polishing. Fillers for Wood and Filling In. Bodying In and Spiriting Off. Glazing and Wax Finishing. Oil Polishing and Dry Shining. Re-polishing and Reviving. Hard Stopping or Beaumontage. Treatment of Floor-Stains. Processes of Varnishing Wood Varnishes. Re-polishing Shop Fronts.

Dynamos and Electric Motors. With 142 Engravings and Diagrams.

Contents.—Introduction. Siemens Dynamo. Gramme Dynamo. Manchester Dynamo. Simplex Dynamo. Calculating the Size and Amount of Wire for Small Dynamos. Ailments of Small Dynamo Electric Machines: their Causes and Cures. Small Electromotors without Castings. How to Determine the Direction of Rotation of a Motor. How to Make a Shuttle-Armature Motor. Undertype 50-Watt Dynamo. Manchester Type 440-Watt Dynamo

Cycle Building and Repairing. With 142 Engravings and Diagrams.

Contents.—Introductory, and Tools Used. How to Build a Front Driver. Building a Rear-driving Safety. Building Tandem Safeties. Building Front-driver Tricycle. Building a Hand Tricycle. Brazing. How to Make and Fit Gear Cases. Fittings and Accessories. Wheel Making. Tires and Methods of Fixing them. Enamelling. Repairing.

Decorative Signs of All Ages for All Purposes. With 277 Engravings and Diagrams.

Contents.—Savage Ornament. Egyptian Ornament. Assyrian Ornament. Greek Ornament. Roman Ornament. Early Christian Ornament. Arabic Ornament. Celtic and Scandinavian Ornaments. Mediæval Ornament. Renascence and Modern Ornaments. Chinese Ornament. Persian Ornament. Indian Ornament. Japanese Ornament.

Mounting and Framing Pictures. With 240 Engravings, etc.

Contents.—Making Picture Frames. Notes on Art Frames. Picture Frame Cramps. Making Oxford Frames. Gilding Picture Frames. Methods of Mounting Pictures. Making Photograph Frames. Frames covered with Plush and Cork. Hanging and Packing Pictures.

Smiths' Work. With 211 Engravings and Diagrams.

Contents.—Forges and Appliances. Hand Tools. Drawing Down and Up-setting. Welding and Punching. Conditions of Work: Principles of Formation. Bending and Ring Making. Miscellaneous Examples of Forged Work. Cranks, Model Work, and Die Forging. Home-made Forges. The Manipulation of Steel at the Forge.

Glass Working by Heat and Abrasion. With 300 Engravings and Diagrams.

Contents.—Appliances used in Glass Blowing. Manipulating Glass Tubing. Blowing Bulbs and Flasks. Jointing Tubes to Bulbs forming Thistle Funnels, etc. Blowing and Etching Glass Fancy Articles; Embossing and Gilding Flat Surfaces. Utilising Broken Glass Apparatus; Boring Holes in, and Riveting Glass. Hand-working of Telescope Specula. Turning, Chipping, and Grinding Glass. The Manufacture of Glass.

DAVID McKAY, Publisher, Washington Square, Philadelphia.

Building Model Boats. With 168 Engravings and Diagrams.
Contents.—Building Model Yachts. Rigging and Sailing Model Yachts. Making and Fitting Simple Model Boats. Building a Model Atlantic Liner. Vertical Engine for a Model Launch. Model Launch Engine with Reversing Gear. Making a Show Case for a Model Boat.

Electric Bells, How to Make and Fit Them. With 162 Engravings and Diagrams.
Contents.—The Electric Current and the Laws that Govern it. Current Conductors used in Electric-Bell Work. Wiring for Electric Bells. Elaborated Systems of Wiring; Burglar Alarms. Batteries for Electric Bells. The Construction of Electric Bells, Pushes, and Switches. Indicators for Electric-Bell Systems.

Bamboo Work. With 177 Engravings and Diagrams.
Contents.—Bamboo: Its Sources and Uses. How to Work Bamboo. Bamboo Tables. Bamboo Chairs and Seats. Bamboo Bedroom Furniture. Bamboo Hall Racks and Stands. Bamboo Music Racks. Bamboo Cabinets and Bookcases. Bamboo Window Blinds. Miscellaneous Articles of Bamboo. Bamboo Mail Cart.

Taxidermy. With 108 Engravings and Diagrams.
Contents.—Skinning Birds. Stuffing and Mounting Birds. Skinning and Stuffing Mammals. Mounting Animals' Horned Heads: Polishing and Mounting Horns. Skinning, Stuffing, and Casting Fish. Preserving, Cleaning, and Dyeing Skins. Preserving Insects, and Birds' Eggs. Cases for Mounting Specimens.

Tailoring. With 180 Engravings and Diagrams.
Contents.—Tailors' Requisites and Methods of Stitching. Simple Repairs and Pressing. Relining, Repocketing, and Recollaring. How to Cut and Make Trousers. How to Cut and Make Vests. Cutting and Making Lounge and Reefer Jackets. Cutting and Making Morning and Frock Coats.

Photographic Cameras and Accessories. Comprising How to Make Cameras, Dark Slides, Shutters, and Stands. With 160 Illustrations.
Contents.—Photographic Lenses and How to Test them. Modern Half-plate Cameras. Hand and Pocket Cameras. Ferrotype Cameras. Stereoscopic Cameras. Enlarging Cameras. Dark Slides. Cinematograph Management.

Optical Lanterns. Comprising The Construction and Management of Optical Lanterns and the Making of Slides. With 160 Illustrations.
Contents.—Single Lanterns. Dissolving View Lanterns. Illuminant for Optical Lanterns. Optical Lantern Accessories. Conducting a Lime-light Lantern Exhibition. Experiments with Optical Lanterns. Painting Lantern Slides. Photographic Lantern Slides. Mechanical Lantern Slides. Cinematograph Management.

Engraving Metals. With Numerous Illustrations.
Contents.—Introduction and Terms used. Engravers' Tools and their Uses. Elementary Exercises in Engraving. Engraving Plate and Precious Metals. Engraving Monograms. Transfer Process of Engraving Metals. Engraving Name Plates. Engraving Coffin Plates. Engraving Steel Plates. Chasing and Embossing Metals. Etching Metals.

Basket Work. With 189 Illustrations.
Contents.—Tools and Materials. Simple Baskets. Grocer's Square Baskets. Round Baskets. Oval Baskets. Flat Fruit Baskets. Wicker Elbow Chairs. Basket Bottle-casings. Doctors' and Chemists' Baskets. Fancy Basket Work. Sussex Trug Basket. Miscellaneous Basket Work. Index.

Bookbinding. With 125 Engravings and Diagrams.
Contents.—Bookbinders' Appliances. Folding Printed Book Sheets. Beating and Sewing. Rounding, Backing, and Cover Cutting. Cutting Book Edges. Covering Books. Cloth-bound Books, Pamphlets, etc. Account Books, Ledgers, etc. Coloring, Sprinkling, and Marbling Book Edges. Marbling Book Papers. Gilding Book Edges. Sprinkling and Tree Marbling Book Covers. Lettering, Gilding, and Finishing Book Covers. Index.

Bent Iron Work. Including Elementary Art Metal Work. With 269 Engravings and Diagrams.
Contents.—Tools and Materials. Bending and Working Strip Iron. Simple Exercises in Bent Iron. Floral Ornaments for Bent Iron Work. Candlesticks. Hall Lanterns. Screens, Grilles, etc. Table Lamps. Suspended Lamps and Flower Bowls. Photograph Frames. Newspaper Rack. Floor Lamps. Miscellaneous Examples. Index.

Photography. With Numerous Engravings and Diagrams.
Contents.—The Camera and its Accessories. The Studio and the Dark Room. Plates. Exposure. Developing and Fixing Negatives. Intensification and Reduction of Negatives. Portraiture and Picture Composition. Flash-light Photography. Retouching Negatives. Processes of Printing from Negatives. Mounting and Finishing Prints. Copying and Enlarging. Stereoscopic Photography. Ferrotype Photography.

Upholstery. With 162 Engravings and Diagrams.
Contents.—Upholsterers' Materials. Upholsterers' Tools and Appliances. Webbing, Springing, Stuffing, and Tufting. Making Seat Cushions and Squabs. Upholstering an Easy Chair. Upholstering Couches and Sofas. Upholstering Footstools, Fenderettes, etc. Miscellaneous Upholstery. Mattress Making and Repairing. Fancy Upholstery. Renovating and Repairing Upholstered Furniture. Planning and Laying Carpets and Linoleum. Index.

Leather Working. With 162 Engravings and Diagrams.
Contents.—Qualities and Varieties of Leather. Strap Cutting and Making. Letter Cases and Writing Pads. Hair Brush and Collar Cases. Hat Cases. Banjo and Mandoline Cases. Bags. Portmanteaux and Travelling Trunks. Knapsacks and Satchels. Leather Ornamentation. Footballs. Dyeing Leather. Miscellaneous Examples of Leather Work. Index.

Harness Making. With 197 Engravings and Diagrams.
Contents.—Harness Makers' Tools. Harness Makers' Materials. Simple Exercises in Stitching. Looping. Cart Harness. Cart Collars. Cart Saddles. Fore Gear and Leader Harness. Plough Harness. Bits, Spurs, Stirrups, and Harness Furniture. Van and Cab Harness. Index.

Saddlery. With 99 Engravings and Diagrams.
Contents.—Gentleman's Riding Saddle. Panel for Gentleman's Saddle. Ladies' Side Saddles. Children's Saddles or Pilches. Saddle Cruppers, Breastplates, and other Accessories. Riding Bridles. Breaking-down Tackel. Head Collars. Horse Clothing. Knee-caps and Miscellaneous Articles. Repairing Harness and Saddlery. Re-lining Collars and Saddles. Riding and Driving Whips. Superior Set of Gig Harness. Index.

Knotting and Splicing, Ropes and Cordage. With 208 Engravings and Diagrams.
Contents.—Introduction. Rope Formation. Simple and Useful Knots. Eye Knots, Hitches and Bends. Ring Knots and Rope Shortenings. Ties and Lashings. Fancy Knots. Rope Splicing. Working Cordage. Hammock Making. Lashings and Ties for Scaffolding. Splicing and Socketing Wire Ropes. Index.

Beehives and Beekeepers' Appliances. With 155 Engravings and Diagrams.
Contents.—Introduction. A Bar-Frame Beehive. Temporary Beehive. Tiering Bar-Frame Beehive. The "W. B. C." Beehive. Furnishing and Stocking a Beehive. Observatory Beehive for Permanent Use. Observatory Beehive for Temporary Use. Inspection Case for Beehives. Hive for Rearing Queen Bees. Super-Clearers. Bee Smoker. Honey Extractors. Wax Extractors. Beekeepers' Miscellaneous Appliances. Index.

Electro-Plating. With Numerous Engravings and Diagrams.
Contents.—Introduction. Tanks, Vats, and other Apparatus. Batteries, Dynamos, and Electrical Accessories. Appliances for Preparing and Finishing Work. Silver-Plating. Copper-Plating. Gold-Plating. Nickel-Plating and Cycle-Plating. Finishing Electro-Plated Goods. Electro-Plating with Various Metals and Alloys. Index.

Clay Modelling and Plaster Casting. With 153 Illustrations.
Contents.—Drawing for Modellers. Tools and Materials for Clay Modelling. Clay Modelling. Modelling Ornament. Modelling the Human Figure. Waste-Moulding Process of Plaster Casting. Piece-Moulding and Gelatine-Moulding. Taking Plaster Casts from Nature. Clay Squeezing or Clay Moulding. Finishing Plaster Casts. Picture Frames in Plaster. Index.

Violins and other Stringed Instruments. With about 180 Illustrations.
Contents.—Materials and Tools for Violin Making. Violin Moulds. Violin Making. Varnishing and Finishing Violins. Double Bass and a Violoncello. Japanese One-string Violin. Mandolin Making. Guitar Making. Banjo Making. Zither Making. Dulcimer Making. Index.

Glass Writing, Embossing, and Fascia Work. (Including the Making and Fixing of Wood Letters and Illuminated Signs.) With 129 Illustrations.
Contents.—Plain Lettering and Simple Tablets. Gold Lettering. Blocked Letters. Stencil Cutting. Gold Etching. Embossing. French or Treble Embossing. Incised Fascias, Stall-plates, and Grained Background. Letters in Perspective; Spacing Letters. Arrangement of Wording and Colors. Wood Letters. Illuminated Signs. Temporary Signs for Windows. Imitation Inlaid Signs. Imitation Mosaic Signs. Specimen Alphabets. Index.

Photographic Chemistry. With 31 Engravings and Diagrams.
Contents.—Introductory: Relation of Chemistry to Photography. Some Fundamental Chemical Laws. Meaning of Symbols and Equations. Water: Its Properties and Impurities. Oxygen and Hydrogen Photographically Considered. Theories Concerning the Latent Image. Chemistry of Development, Toning, Intensification, etc. Nitrogen Compounds Employed in Photography. The Halogens and Haloid Salts. Sulphur and its Compounds. Metals, Alkali Metals, etc. Organic or Carbon Compounds used in Photography. Pyroxyline, Albumen, Gelatine, etc. Benzene and the Organic Developers. Index.

ORNAMENTAL TURNING

ORNAMENTAL TURNING

A WORK OF PRACTICAL INSTRUCTION IN
THE ABOVE ART

BY

J. H. EVANS

IN THREE VOLUMES

VOLUME II

WITH NUMEROUS ENGRAVINGS AND PLATES

PHILADELPHIA
DAVID McKAY, PUBLISHER
610, SOUTH WASHINGTON SQUARE
1910

Printed in England

PREFATORY NOTE TO SECOND VOLUME.

Although my name appears as the writer of this volume, I have with gratitude to express my obligation to S. R. Bottone, Esq., of Wallington, Surrey, for his valuable chapter on Electrotyping.

J. H. E.

CONTENTS OF SECOND VOLUME.

CHAPTER I.

THE UNIVERSAL CUTTER.

CHAPTER II.

THE DRILLING INSTRUMENT.

CHAPTER III.

IVORY VASE.

CHAPTER IV.

THE CURVILINEAR APPARATUS.

CHAPTER V.

THE ECCENTRIC CHUCK.

CHAPTER VI.

CYLINDERS DECORATED BY THE ECCENTRIC CHUCK.

CHAPTER VII.

THE ELLIPSE CHUCK.

CHAPTER VIII.

COMPENSATING INDEX FOR THE EQUAL DIVISION OF THE ELLIPSE.

CHAPTER IX.

THE RECTILINEAR CHUCK.

CHAPTER X.

THE DOME OR SPHERICAL CHUCK.

CHAPTER XI.

ELECTROTYPING.

ILLUSTRATIONS OF SECOND VOLUME.

PLATES OF SECOND VOLUME.

ORNAMENTAL TURNING.

CHAPTER I.

THE UNIVERSAL CUTTER.

THIS instrument is similar to the vertical and horizontal cutter in many respects, but from its being made to set to any angle midway between its horizontal and vertical positions, its powers are greatly increased.

Fig. 121

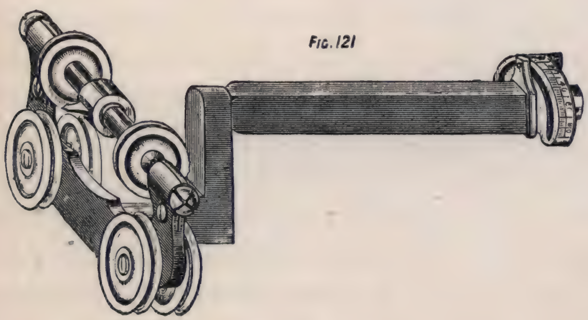


Fig. 121 represents, to a certain extent, one of modern style, but like many other tools it has its

defects. The spindle, which is forged in the solid with the frame, passes through the square stem and has fitted on the end a gun-metal arc, which is graduated on both sides of the zero from 0° to 90°, and fixed by a screw against a steel plate on which the reading line is marked.

The spindle that holds the tool revolves between two centre-screws, which serve also for the finer adjustment of the height of centre when the tool is cutting in the horizontal position. On each end of the spindle a driving-pulley is fixed, and when used in an angular or horizontal position the driving-band is conducted to it by a pair of guide-pulleys attached to each end of the frame. The spindle has a mortise hole in its centre, more or less, like all other instruments of this character.

Although a useful instrument for its various purposes, it is limited somewhat by the small amount of radius to which the tool can be extended without coming into contact with the frame, and from the size of the latter coupled with guide-pulleys on each side, it is prevented from being placed in sufficiently close contact with many kinds of work; it has also been found wanting in power for deep cutting.

Fig. 122 is a new description of universal cutter, designed by the author, and its advantages are obvious. First, it has greatly increased power from the speed obtained; the tool can be placed close to the work

in every direction, the driving-pulley is entirely out of the way of the work in all cases, in fact, it affords many facilities not to be obtained by Fig. 121 without being encumbered by extra guide-pulleys, and is more convenient and effective in every way.

The spindle is forged in the solid with the arms, and is fitted through a square stem in the same way as Fig. 121. On the front of the square stem there is a

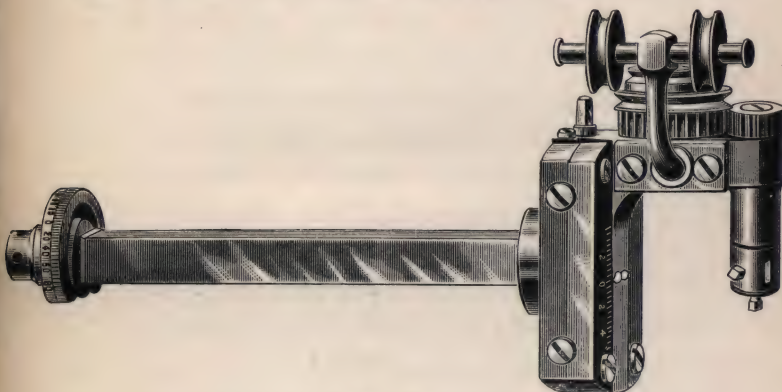


Fig. 122.

round collar, $1\frac{3}{8}$ in. in diameter, for the face of the arm to bear against to prevent any vibration. In the arm a steel collar is fitted, into which the spindle that revolves and holds the tool is fitted; this is also coned in the front. On the top of the spindle a pinion of nineteen teeth is fixed, having also a steel collar in it; this is held on firmly by a steel screw in the end of the spindle; behind this a steel stud with a cone at the base is fixed,

on which a wheel of forty teeth is fitted to revolve and gear accurately with the pinion on the spindle in front, and is retained in its place by a steel screw in the stud.

It will be seen that the driving-pulley, which is fixed to the wheel, is entirely out of the way, leaving the front of the frame and the spindle free to be presented close to the work, and, by using a short tool, vertical cutting of a distinct and unique character may be executed. On the right side of the frame a curved arm is fixed, which has a transverse bar, on which a pair of guide-pulleys revolve similar to those on Fig. 118, also with power of self-adjustment. The pulley has two speeds, and the wheel-gearing being in the proportion of two to one, a quick speed is obtained. As in the case of the old-fashioned vertical cutter, it has been argued that this style of instrument is likely to wear to an angle by the pressure of the band, also that the wheel-gearing is likely to leave its mark upon the work; but this is entirely a mistake, if the instrument is correctly made. This particular design of instrument has met with great favour with many leading amateurs, and has given every proof of its efficiency.

A second spindle is sometimes made to carry circular cutters, or a thin circular saw like the horizontal cutter. Another advantage it has is, that a long tool, such as the slide-rest tools, can be used at a radius of 1½ in.,

describing a circle of 3 in. in diameter. This is a great convenience in cutting large patterns when it is found necessary to set the tool to an angle. The tool when fixed with the spindle in a vertical position points to the axis of the shaft, which passes through the square stem, and, when set for work to be cut at the centre, is identical with the axis of the lathe mandrel. The divided arc at the back is in every respect the same as that in Fig. 121.

A very great advantage is manifested by the instrument being set to various angles between the vertical and horizontal positions. Fig. 7, Plate 3, shows the effect of it employed upon a cylinder to form a column, which may be cut in any number of different ways. It was first turned to a cylinder $\frac{7}{8}$ in. in diameter, the slide-rest set parallel with the lathe bearer, the universal cutter (Fig. 122) placed in the tool-box, and set over to an angle of 60°. The first cut is then made with the index at zero, 96 being again used. The tool is made to penetrate, so that the actual cuts are below the original diameter of the cylinder. Having carried the cuts round at every six, the tool is moved laterally $\frac{1}{10}$, by one turn of the main screw, which will bring it to the desired position for the succeeding cuts. Although in appearance it is somewhat similar to the basket-work, it is totally different, and it does not necessitate any further movement of the index beyond

a repetition of the movement to every sixth hole, therefore it is only necessary to continue this, and for each series, move the tool forward one turn. Here again many variations may be made, and useful decorative results produced.

The advantages obtained from the ability to set this instrument to any angle between the vertical and horizontal position is not confined to work executed upon the cylinder. It is equally effective when devoted to work ornamented upon the surface. Fig. 8, Plate 3, represents an example of the effect produced by the cutter being set to an angle. It is an extremely simple pattern, but will show clearly what a wide range is possible in such work.

The face of the work is first turned perfectly true and flat, the tool then extended to a radius of $\frac{8}{10}$, and cut round at every six of the 96 divisions, the instrument being set over to an angle of 55°. Having cut round thus, the instrument is reversed to the same angle on the opposite side and the pattern cut over again.

The universal cutter (Fig. 122) may be employed for Fig. 9, Plate 2, and the small screw in the end of the spindle, used for keeping the tool always in the same position as to centre, may be the means of holding it alone, and the screw passing through the side of the spindle removed; thus, with a short tool, a very small

radius is obtained, and the beauty of the work when cut is greatly increased.

To cut a similar figure to that now being considered, there are one or two points, the explanation of which will be of value. The work is first turned smooth and true, the slide-rest, of course, set transversely across the bed, the universal cutter (Fig. 122) placed in the tool-box; a square-end tool (very short) is then fixed by the screw in the end, and that usually employed removed, a tool, $\frac{6}{100}$ in. wide, is adjusted to a radius of $\frac{4}{10}$, the index set at 96, the slide-rest arranged so that the micrometer stands at zero, the tool made to penetrate deep enough to bring the points up, and cut round at every six. The tool is now moved laterally by turning the slide-rest screw exactly one half-turn, which is equal to $\frac{1}{20}$ in., or $\frac{1}{100}$ less than the width of the tool, the division-plate moved two holes, and the cut repeated at every six. This is, so far, precisely similar to the movements required for the same process on the cylinder as seen by Figs. 3, 4, and 5, Plate 2. It will be observed that the tool used for the figure under notice is $\frac{6}{100}$ in. wide, although the lateral movement is only $\frac{5}{100}$. The reason of this is, that the cutter revolves in a true vertical plane, and, when the work is moved round by the two divisions for each succeeding cut, the terminal points produced are really at angle one to the other, and if the width of the tool is identical with the movement

of the slide-rest, a very small portion is left adhering to each point, which is a decided objection, and the removal of it is not practicable without considerable risk of damage to the work. This process is repeated eight consecutive times, with the result that the pattern formed is of a semi-spiral character, as seen by the illustration.

Having made the eight cuts, the remaining portion is taken out to the centre by the traverse of the slide-rest, the fluting-stop being fixed on the left side, so that no damage can occur to the last series of the basket-work; the centre is then filled with a small plain semi-circular piece of ivory. These patterns, like all others, may be increased to any extent, and cut in both ways, or otherwise varied to suit the taste of the operator.

The ivory paper-box or sugar-sifter represented in Plate 4 is a useful and ornamental subject. It may be produced with either the universal or horizontal cutter. The former was employed for the subject now illustrated. It is composed of six separate pieces, which, for many reasons, is more advantageous, economy of material being not the least important, the facilities for chucking and the ready means of ornamenting being a great consideration.

When reproducing this or any similar object, it should be first turned and put together in the plain

Plate 4.

form, to determine the necessary proportions. In the present instance the foot had a plain recess about $\frac{1}{4}$ in. deep and 1 in. in diameter turned in the base, by which it was chucked on a boxwood plug, the hemispherical body was then turned out inside and screwed to receive the top, and by this screw it was again chucked, and the opposite extremity screwed to fit a corresponding thread on the foot. The base of the first concave curve which forms the top was then screwed to fit the body, and attached also to a wood plug. The second concave portion is then treated in a like manner.

These parts being thus attached to separate chucks, can be put together to prove the proportion, the foot being left on the chuck to which it is fitted. The contour of the figure being satisfactory, the different parts may now be ornamented, the foot or base being the first to be done.

The slide-rest is set parallel with the lathe-bearer, and the universal cutter placed in the tool-box with a round-nosed tool, the instrument being set so that the tool revolves horizontally. When the radius of the tool is adjusted, it is revolved at a high speed and the work slowly rotated by hand. Having by this means obtained the necessary curve, the round-nosed tool is replaced by a double quarter-hollow, Fig. 73, the index set to zero of the 96 division and the tool penetrated at every fourth hole, the fluting-stop on the left side being set to arrest the cut at the desired depth.

When cutting reeds on a curve of this character, it will be noticed that they differ in shape at the diminished diameter. This is caused by only a very small portion of the tool taking effect at that part, while at the larger diameter its full figure is employed.

The base being so far finished, a small ring, having fourteen beads cut with a drill, is next fitted; the body is then mounted on the dome or spherical chuck (Fig. 168), the universal cutter is turned to 90° on the right side, which will bring it to the reverse position to cut vertically; and having been carefully sharpened, the same tool, Fig. 73, is used. The work is then set by the screw of the dome-chuck, so that when rotated, or rather partially so, the tool will follow the curve. It is then made to penetrate to the depth required, which is ascertained by trial cuts, and the segment-stop used to arrest it at the centre. The wheel of the dome-chuck is then moved round by three turns of the tangent screw for each successive cut, which will produce thirty-two consecutive incisions. This operation will be again referred to in the details of the dome or spherical chuck.

The upper part is then placed on the lathe, and the row of beads, forty in number, cut with a bead drill $\frac{12}{100}$ in. wide, the universal cutter is again placed in the slide-rest and turned to zero, to cut horizontally, the same double quarter-hollow tool being used, set to the

desired radius, and a similar pattern to that on the foot repeated. A third row of beads, a size smaller and twenty-four in number, are then cut; and the second concave curve cut in the same way as the first; the fourth row of beads is then cut, the convex top with a series of holes, and the plain curve, forming the finial.

This particular specimen, although not elaborate, serves in every way to illustrate the use of the instrument employed, which may lead to very interesting results indeed.

CHAPTER II.

THE DRILLING INSTRUMENT.

This instrument affords such a very large field for variety of application that it is one of the most important of the series used in connection with the art of ornamental turning. Its employment extends to the decoration of pillars, surfaces, cones, curves, and numerous compound solid forms, and it operates more or less in conjunction with all the ornamental chucks and different apparatus. It will be constantly referred to as the various specimens illustrated in the plates are approached, from which a general idea of its manipulation will be gathered.

When used for the purpose of fluting a column, reeding the body of a box, or similar object, the length of each flute is determined by the fluting-stops, which are fixed at the desired point on the slide-rest, thus arresting the progress of the drill. When used for the purpose of beading or piercing, the instrument once placed in position, will not require lateral traverse of the main slide, the penetration

being decided by the depth and stop-screw of the top slide.

Fig. 123 illustrates a drilling instrument of the most modern form; the spindle is made to pass through a square steel stem of the standard size, having in each end a hardened steel collar, coned at the mouth; the corresponding cone on the spindle being made to fit it accurately. On the rear end of the spindle a steel driving-pulley is attached; in this also a hardened collar is used with a similar cone to that in the stem. The object of the double cone is to admit of the accurate fitting of the spindle being maintained, and when any play between the two arises from the constant wear of continued revolution, by tightening the screw at the back of the pulley the spindle may be again adjusted to a perfect fit. This is a most essential point, as undue freedom in this respect prevents the work being cut as smooth as it should be.

Fig. 123.

The front is bored out to a taper hole, to receive the

shank of the drills, and has a mortise filed across the end of the hole at a right angle to its axis; the shank of the drill is fitted accurately to the taper hole, and the end filed down to the centre, to fit on to the flat of the mortise, one side of which is filed accurately to the diametrical line; the object of this particular style of fitting is to prevent the drill from turning in the hole, which from any extreme pressure it is likely to do; the aperture also affords a means of extracting the drill by inserting a small lever or wedge and forcing it forward, which is necessary in its removal, as the drill must fit firmly in the hole. It is, however, the taper hole which is relied upon for the truth of the drill, the fitting at the end being the means, as before stated, of preventing its turning round.

Fig. 124.

Fig. 124 shows the same kind of instrument with the pulley fitted to the front instead of the back. This has many advantages, especially when used in the spherical slide-rest. Those amateurs who have had

experience with this particular kind of slide-rest may have found that when cutting a series of flutes round a sphere, that the band from the angle at which it inclines is likely to run off the pulley of the instrument. There is not so much danger when the overhead motion (Fig. 11) is employed; in which case it is not likely to occur, owing to the pulley being placed on the front of the instrument causing the band to run at a much less angle; because, when the circular movement of the rest is rotated, the band moves within a radius of very much less diameter than when the pulley is at the back, the difference consisting in the length of the stem of the instrument.

A few hints as to making the drills may be of service to many amateurs, and will assist them in replacing a fractured one without being compelled to forward the spindle to the maker, which is generally the case, as all such tools must be turned in their own spindle. The shank is first turned down to fit accurately into the tapered hole; it is then filed at the end on one side to fit the mortise; the spindle is then mounted on the slide-rest, preferably a metal turning one (Fig. 18), so that the hand-rest can be got to it. It is then driven from the overhead motion, and the drill turned true, and to the size required.

In some cases the figure of the drill, if a moulding tool, may be turned approximately to shape; when so

turned, a minute point should be left at the end perfectly true to its axis, this acts as a guide to file the surface, which must be reduced exactly to the half of the test point. It is necessary that great care be used in this respect, as the accuracy of the drill depends upon it; as an example, if the face is reduced below the centre, when used for piercing or beading, a dot will be left at the centre of the figure; if the surface is left above the centre it will not cut cleanly.

Fig. 125.

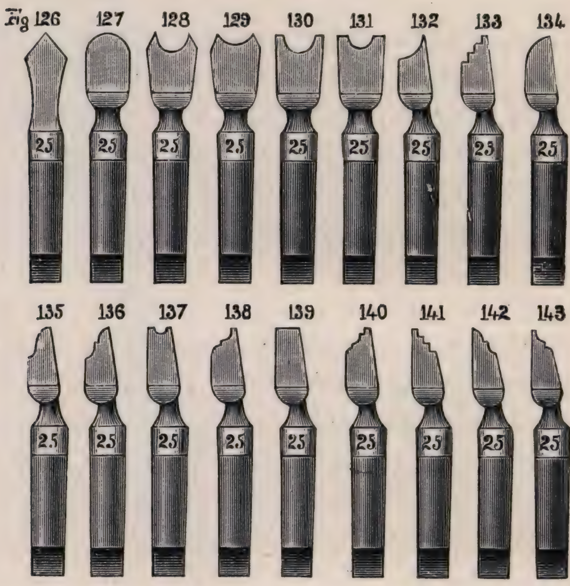
When making moulding-drills, which have their cutting edges to the left side of the stem, after the shank is fitted, the tool is made red-hot, then placed in a steel socket made to receive it, and the front, or blade, bent over to the left side; it is then replaced in the spindle, and a test-centre formed by turning a minute point. The face of it is then reduced to the diametrical line, and the right side

filed at an angle until it is also reduced to the exact half of the test on that side of the centre; the cutting angle is then filed to about 35°, and the back of the drill reduced to the required substance. The next process will be to harden and temper it; and here difficulties may occur, from the tendency of the blade to depart from the actual truth; it is always preferable to heat the shank first, and let it run down gradually, having a vessel of water at hand to cool it immediately the proper heat is obtained, which, with fine steel, should be a very deep blood-heat; any excess in this operation will render the drill worthless.

The face should now be cleaned, and the drill tempered to a light straw colour; this may be done either by holding the shank in a small pair of red-hot tongs, or by heating it with a blow-pipe. Upon replacing it in the spindle, it may be found to run out of truth, which is the result of the heat it has been subjected to in the process of hardening. This may be corrected with a small hammer, by the narrow end of which the hollow of the drill is struck, until its original position is regained; fresh disasters may again arise, as they very often break short off.

It often happens that in spacing out the work too great a distance will occur between the cuts, this may be altered by advancing a less number of holes in the division-plate, or by employing a drill a size larger, or,

on the other hand, if the beads are too close together, a drill of less dimension may be used. From this will be seen the necessity of making such drills of gradually increasing sizes; they are generally made to vary from $\frac{4}{100}$ to $\frac{35}{100}$ in.



By reference to the engravings, Figs. 126 to 131, it will be seen that these drills have their centres precisely true, both axially and diametrically. Fig. 126 is a plain drill for piercing holes. Fig. 127, a plain round-nosed fluting-drill, it can, however, be applied for many other kinds of seriated or continuous figures. Fig. 128, a pointed

bead-drill, is perhaps one of the most important of the series. It produces beads of different diameter, according to the size of the tool; but such a drill cannot be moved laterally without destroying the figure. Fig. 129 is a tool of the same character, but made with a less amount of curve, which is at times desirable. Fig. 130 is also a beading-drill, but with astragal or square end in place of the point, as in Fig. 128. Fig. 131 is a similar style of beading-drill, having wider astragals, so that the beads may be left wider apart, and thus prevent any possibility of the external diameter of the tool interfering with, or distorting the bead previously cut. A square end or chisel-drill is a most useful kind, either for piercing seriatim, or for producing long flutes with a flat surface at the bottom and square sides, in distinction to the shape left by the drill (Fig. 127).

Fig. 132 represents the first of what may be termed the second series of drills, and it will be seen that it is of an entirely different construction, inasmuch as its centre is reduced to the diametrical line, and the cutting edge all on the left side of its axis, and as illustrated, all the tools in this series are made in the same way. Fig. 132 is a quarter-hollow reeding-drill, and will produce work similar to that seen on the body of the ivory pepper-box, Plate 4, when used in conjunction with the dome-chuck. Cylindrical or taper pillars may also be decorated in the same way. Fig. 133, a step-drill, is

used to ornament work in a number of different ways, one of the most effective being long step flutes, either on cylinders or surfaces; and when applied in combination with the spiral apparatus to cut a long twist, very beautiful results are obtained. Fig. 134 a quarter-round drill, is used principally to scallop out the interior, or the edges of various works requiring to be so excavated. Fig. 135 is an ogee moulding tool, used for cutting flutes of the same shape, or for seriated mouldings. Figs. 136, 138, and 140 are also for the same purpose, resulting in the figure of the tool, and the shapes may be multiplied in form and size to almost any extent. Fig. 137 is a tool which produces a small ring of the shape the tool is made, the centre of the bead being eccentric to the axis of the drill itself. These tools are made in many different forms, and are extremely useful in various ways, but from their construction it will be seen they cannot be traversed laterally. Fig. 139 is a routing-drill, also a very useful tool for fluting or cutting out semi-circular recesses with the segment apparatus, or in combination with the ornamental chucks.

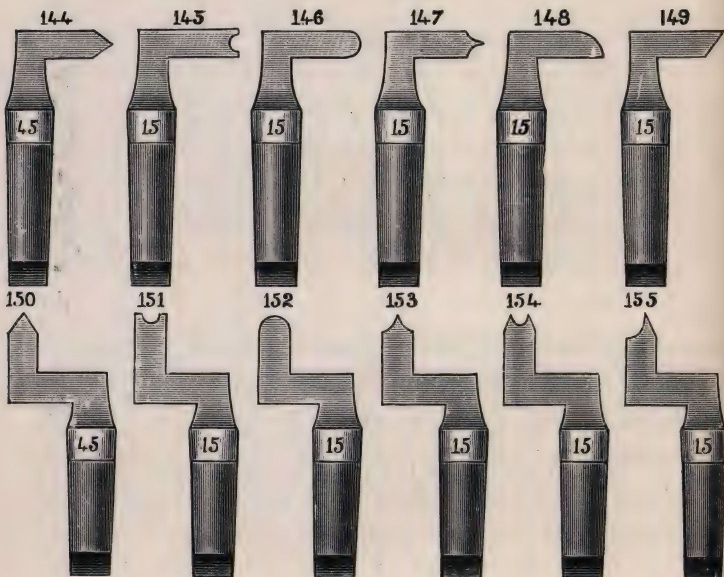
Figs. 141, 142, and 143 are examples of the moulding-drills, which produce pyramids of their own form, in distinction to the previous series, which execute flutes of similar shapes. These have the figures made in the reverse way, so that it is reproduced in a pyramidal form, and for many styles of decoration are most

essential. These, like Figs. 128 to 131, cannot be traversed laterally, but are only used for producing their forms, as above mentioned. All the drills alluded to in this series are made in different sizes, varying from $\frac{4}{100}$ to $\frac{40}{100}$ in. wide, but when larger than $\frac{25}{100}$ wide are generally fitted to a spindle having a larger hole and a binding screw instead of the transverse mortise, as the power required to drive them for deep cutting is more than the smaller shank will bear without vibration, also the increased size of the cutting edge cannot be readily obtained from material used for the smaller drills.

Figs. 144 to 149 illustrate bent drills, and the shape of the cutting part is made similar to those already described. These are from preference fitted to the spindle with the large hole. The figures stand at a right angle to the stem, and are employed mostly for internal work, after the same manner as the internal cutter (Fig. 125), but the depth of their operation is limited. A certain amount of basket-work can also be executed on the face by setting the slide-rest parallel with the lathe-bed, which it will be seen brings the bent cutter to the same relative position as the vertical cutter would be in with the slide-rest adjusted in the reverse way. When these tools are made with a very small radius, they may be applied where it is impossible to get the internal cutter. Like their predecessors, they also require to be made in sets of different radii and

widths, as there is no power of extending or reducing the same, except by changing the tool. They are made with the cutting edge to the right, as seen in the engravings.

Another form of drill, or rather cutter, is illustrated



by Figs. 150 to 155. These to a very great extent supply the place of the eccentric cutter, and in a few instances are used with good effect, inasmuch as the absence of the right angle slide of the former will allow patterns to be cut which could not be done without them, especially when the work is placed upon either of the

ornamental chucks, the projecting slide at times preventing the eccentric cutter being placed in contact with the work. These, it will be seen, are made precisely the same shape as those in the previous series.

Having given a brief outline of the various drills, it may be mentioned that they will be referred to in many instances connected with the description of the various specimens of turning. The examples on Plate 5 having been done entirely with drills, affords an opportunity of illustrating the way in which they were used for such work. Fig. 125 shows the internal cutter; it is made in the same way as the drilling instrument, with the exception that the spindle is much longer in front, and, instead of a hole bored to receive a drill, a transverse mortise is filed to fit the eccentric cutter; it is used for decorating deep interiors. It has been found a most useful addition to this instrument to have a few drills fitted to the end; it does not interfere with the mortise hole at all, and enables work to be done at the bottom of a deep cylinder that could not otherwise be accomplished.

SPECIMENS OF DRILL WORK.

Following the details of the drill-spindles and the various drills, which may practically be multiplied to almost any extent, the specimens of work executed with the same, and illustrated in Plate 5, will now be

considered, and as there are many different ways in which the drill has been employed, it is hoped it will be found a means of elucidating many of its applications for work of a similar class.

The tazza (Fig. 1) is made in four pieces, and in the first instance the parts are screwed together and the desired shape and proportions satisfactorily decided, the base, which in the first instance is semi-circular, is turned out inside, and then fitted to a corresponding form on a boxwood chuck and glued to it; the diameter of the base is barely 3 in. A plain flat-end drill $\frac{25}{100}$ in. wide is first employed, and twelve holes bored $\frac{5}{20}$ in. from extreme base; the 96 circle of the dial-plate is used and moved to every eighth hole for the twelve consecutive cuts. The drill is then moved $\frac{3}{20}$ nearer the edge, the division moved four holes forward, and the drill penetrated again at every twelfth hole from that point. Upon completion of this, the dial-plate is moved to four holes on the opposite side of the zero, and the twelve cuts repeated. This, it will be seen, leaves only a portion of the curve cut by the drill on the work, the result being that the three holes represent a kind of semi-Gothic form.

The plain drill is now removed, and a moulding-drill substituted. The figure of the latter being a quarter-hollow, with a fillet and astragal end, the division-plate is moved four holes, so that the centres of the three

Plate 5.

following cuts will be in the centre of the space left from the three holes previously cut. Having cut round at every eighth hole, the dial-plate is moved four holes on one side of the starting-point, and the slide-rest moved $\frac{1}{10}$ laterally to the right and the cuts repeated all round, the dial-plate is moved four holes on the other side, and the same process repeated. The slide-rest, while these two series of cuts are being made, is set to an angle, about 15°.

The rest is now moved to an angle of 40°, and a large pointed bead-drill, $\frac{35}{100}$ in. wide, replaces the moulding tool. The starting-point for this drill will be the same as that previously used for the moulding tool, but, as there are eighteen beads, every third only will present itself to the centre of the spaces left. The eighteen beads are then cut, great care being necessary in letting forward the drill. As the 96 circle cannot be equally divided into 18, a fresh division must be employed, the 144 divided by 8, and being drilled on an arc as previously described, no difficulty will arise in changing from one division to the other; a small step-tool is then placed in the spindle, the division moved to half the number of holes, so that the point of the drill is placed between the beads, the slide-rest moved $\frac{3}{20}$ to the left side, and the drill penetrated the necessary depth. A small round-nosed drill is then used for a similar operation on the opposite side, the index is

removed to the 112 circle, and the same drill inserted at every hole; the closely seriated pattern thus produced is a great relief to the larger and more prominent work.

The slide-rest is now turned to the surface, and the same pattern produced by the moulding tool in the second group is again carried out on the face, the terminal points being cut with a plain flat-end tool $\frac{14}{100}$ in. wide. So far the base may be considered finished, and can be removed from the chuck by immersion in warm water.

The short cylindrical part extending from the base, having been carefully fitted to a boxwood plug and glued, is next drilled out, the slide-rest again set parallel with the lathe bed, a piercing drill $\frac{6}{100}$ in. wide is employed, and when commencing a piece of work requiring as this does a great number of holes, it is advisable to have two or three duplicate drills, in case of an accident. First drill the twenty-four holes nearest the base, using the 96 circle, advancing four each time; having drilled these, move the slide-rest laterally one half turn, and advance the dial-plate two holes; drill round at every fourth hole, move the dial-plate one hole, and the slide-rest another half turn of the screw to the right; drill round and then move the division-plate to one hole on the opposite side of the zero, and drill round again, move the dial-plate back to the zero as used for the first hole, and the slide-rest another half turn further

still to the right, and again drill round, and the result is as seen in the illustration, which may be continued through any space required.

The dish, or tazza, may be next operated upon, the same drill being employed. The lower series of holes forming the fringe is drilled first; there are ninety-six, and the drill is adjusted to leave rather more than the semi-circle, which gives it an elegant finish. Above these are seventy-two beads, to produce which a pointed bead drill $\frac{8}{100}$ in. wide is used in place of the piercing drill; they are spaced to approach as closely as possible without touching each other, employing the 144 circle, every alternate hole being used. Beyond these beads, forty-eight holes are drilled in the lower part, with the same drill as previously used. Having drilled these, the remaining part is executed in precisely the same way as that forming the first example of this style of decoration. Close above the intervening plain curve, one hundred and twenty smaller beads are drilled with a pointed drill $\frac{6}{100}$ in. wide, also in close proximity one to another.

The single row of pierced work at the top has forty-eight holes, cut at four consecutive operations, resulting in the same figure as the lower part, which has been drilled in the same way. Having drilled this circle, a small step-drill is inserted above each hole, and the terminal pattern on the top cut with a small drill

similar to Fig. 150. This can of course be cut with the eccentric cutter, but these specimens being entirely the result of employing the drill-spindle, that alone was used.

The stem is cut with a step-drill and the spiral apparatus, the wheels of the train being 144 on dividing chuck gearing to 18 on double arbor, 120 on the same gearing to 15 on lower socket or slide-rest. To cut the reverse twist on the upper part, the intermediate arbor with wheel of thirty teeth is interposed between the 144 and 18. This example, in its entirety, is really more a matter of patience than anything else, one of the principal things being the chucking of the various parts.

Fig. 2 in the same plate is illustrative of the drill when employed to produce the beads in a more prominent form, and when so cut are termed pearls. This is by far the most effective style of ornament, and does not require at all a difficult manipulation of the instrument. There are two distinct ways of obtaining the same result, that is, the drill may be presented to the work at two or more different angles. The example under notice was cut in the following way: The part upon which the pearls are to be cut is first turned to the width and depth of the drill to be used, and as those on Fig. 2 stand at an angle to the surface, the slide-rest was adjusted to 45°, the drill then inserted to

complete the bead at that point. The slide-rest was then set transversely across the bed, and the drill carefully adjusted to remove the superfluous material on the front; the rest is then set parallel to the bed, and the material cleared from the opposite side. By this it will be seen that, to produce the pearls in relief, as illustrated, three distinct settings are necessary, and all that is required to obtain a satisfactory result is extreme care in the adjustments. The face and concave curve were cut seriatim with a large-size round-nosed drill.

With beading work of this character much depends upon the way in which that part of the work upon which they are to be cut is prepared, and the close proximity of the beads is at times a difficult matter, requiring a careful selection in the size of the drill and the division employed; it is sometimes an advantage to have a greater interval than can be cut with the astragal sides of the drill. In this case the beads can be placed as desired, and the interval afterwards removed by other means.

The perfection of the cutting edge of the tool must be carefully studied in every way, and after cutting a number of pearls in the rough, so to speak, the tool should be carefully sharpened for a finishing cut.

Spiral forms of many different degrees of twist may also be produced, either in recessed or projecting figures; as an example of this particular style of decoration,

suppose a long pillar is required to be so treated, it will require the support of the popit-head; the first series of holes would be drilled at a certain division, for the second row the drill is moved laterally by the main screw of the slide-rest, the division moved forward two or more holes according to the twist desired, and the drill inserted again. These movements are repeated throughout the entire length of the shaft, unless the twist is to be made in the reverse way for the second half, in which case the division-plate will require to be moved in the opposite direction.

The majority of the plain and moulding-drills may be employed for the purpose of fluting or recessing the various portions of work, either seriatim or continuously, and the perforations at times are so arranged that they cut into those preceding and following; they may be also spaced to leave an interval or plain part, which may afterwards receive some other description of ornament.

Star patterns and facial decorations also afford considerable scope for display of taste and design. Fig. 3 is a simple example of the former. It is in the first place held in a boxwood chuck, faced over perfectly flat and screwed in the centre; it is then fixed to another chuck equally flat, and screwed at the centre to fit the hole in the ivory; a little thin glue is then put on the face of the chuck and the ivory screwed up to it. If

allowed to get thoroughly dry, such work will receive safely almost any amount of perforation, and it will not splinter away when the drill passes through at the back, as it is in close contact with the face of the chuck.

The external diameter is then turned to $1\frac{1}{2}$ in. diameter, and the face hollowed away gradually until the edge is $\frac{1}{20}$ in. thick. The plain form thus turned should be highly polished, which adds greatly to its ultimate appearance, and cannot be done after it is cut or pierced. A square-end bead-drill, $\frac{5}{10}$ in. in diameter (keenly sharpened), was used to cut out the largest curves on the edge, which are twelve in number, the 120 division, arrested at every ten, being employed. The large drill is then replaced by one $\frac{2}{10}$ in diameter, and moved towards the centre by the main screw of the slide-rest, so that it will cut partly into the hole made by the one first used. A small drill, $\frac{6}{100}$, is then arranged to cut the small hole nearer the centre and opposite the aperture.

The division-plate is then moved five holes, to bring the following series in the centre of the part left uncut from the previous perforation, the drill, one of $\frac{15}{100}$ in., is then moved laterally two whole turns of the main screw, and a hole pierced at every ten. A drill of $\frac{6}{100}$ in. is then employed to pierce the two sides, the centre of the drill being adjusted to cut a semi-circle only. The same drill is then set to pierce a hole in the

centre of the points left from the primary cut, and another drill of $\frac{4}{100}$ in. is then traversed forward to the centre by one and a half turns of the screw. A drill of $\frac{3}{100}$ in. in diameter is then employed for the inner circle, to complete the star. The drilling instrument thus used will result in some very excellent and highly decorative ornaments.

Vandykes cut upon the lips or edges of vases or other subjects are also a most effective class of work to produce with the drill; and these may be arranged in many different ways, the perforation in some cases being in contact, while in others spaces may be left between each. The vandykes may be cut out either with a drill similar to that used for the star, or with a routing-drill (Fig. 139). Fig. 4 is a simple pattern of this character, and was cut with a series of different-sized drills.

The work is first turned to the necessary diameter inside, then chucked on boxwood and glued. The outer diameter is then carefully turned and polished. A square-end drill, $\frac{5}{10}$ in., is then employed to cut out the largest curve, which, when cut all round at every four of the 96, leaves twenty-four points, a few only of which are seen in the illustration. The slide-rest for this operation is set parallel with the lathe-bed, and the drill penetrated clean through into the boxwood plug, by which all chance of splintering the ivory is prevented. The points being perfectly sharp and delicate, great

care must be exercised, as the absence of one of them, caused by a fracture, entirely mars the beauty of the work. The drill is changed for one of $\frac{2}{10}$ in., and then moved by the slide-rest screw one turn and a half to the right, so that the hole pierced by it will cut into that previously drilled. A third drill, $\frac{1}{10}$ in., replaces the second, and the slide-rest again moved one turn and a half, or $\frac{3}{20}$ in., in the same direction. The index is then moved forward two holes, so that the drill that follows is presented to the centre of the form left from the previous perforation. The diameter of the drill is $\frac{16}{100}$ in., and the position laterally being the same, its centre is opposite the points left by the last drill used for the first series. A drill of $\frac{8}{100}$ in. is now substituted and moved laterally one turn and five divisions of the micrometer, so that about two-thirds of its entire diameter are left. The final drill used is one of $\frac{4}{100}$ in., moved laterally to pierce the centre of the diametrical line cut by that previously employed, and afterwards arranged to pierce the spaces resulting from the last cut of the first series and the first of the second. The top of this pattern is set off by a circle of small beads, cut with an astragal bead-drill, $\frac{5}{100}$ in. in diameter, using the 120 circle of division moved to every hole.

The proportion of the vandykes will depend upon the diameter of the material to receive them, the number required in a given space, and the diameter of each

consecutive series of drills. The points may result from a series of perforations all executed with the same drill, and as before stated, there is practically no restriction to the variety of forms to be obtained from the above and similar proceedings.

A very effective result is obtained by using a round-nosed drill in the following manner, either on the diameter of a cylinder or the face of the work (a drill about $\frac{20}{100}$ is a very good one to employ): cut all round at such a number that each succeeding cut will overlap or cut into the neighbouring one, then move the index exactly half the number; move the slide-rest laterally, so that the drill will cut as nearly as possible the same amount into the side of the circle, and cut again all round at the same number used for the first. The second circle being cut, the index is moved back to the zero, and the slide-rest moved the same distance, denoted by the micrometer; by these alternate movements, the pattern terminates similar to a honeycomb, and for some subjects is most appropriate. The drilling instrument will be again referred to as the different illustrations are approached.

CHAPTER III.

IVORY VASE.

PLATE 5A illustrates a specimen of a vase or urn, of a very distinct character. It is a subject which is, and probably always will be, one of the first to attract the amateur turner, especially the beginner. Any turner, however, might essay to reproduce it, no doubt in many cases embellishing it with various additions and improvements. When I say, however, that I am indebted to one of our most experienced and best turners (Wilmot Holland, Esq.) for the privilege of illustrating the present subject, it is obvious that it will require a deal of thinking out to make any alterations with marked effect. It is also a subject that will contain repetition, insomuch as the outline or profile may be designed in endless ways if deemed necessary, and consequently the decoration may be described in the same category.

The first part to undertake will be the base, or foundation. This, as will be seen, is composed of African blackwood, which should be surfaced on one side. After a hole has been bored through the centre,

it is rechucked on a boxwood chuck with a short pin to fit the centre hole. The front is then surfaced, and reduced to the desired width. Then the periphery is turned to the diameter of the corners of the facets, when the plain turning is completed.

Following this we come to the primary part of the decoration, viz. the cutting of the eight facets, which form the octagonal form illustrated. First set the slide-rest parallel to the lathe-bed, place on it the eccentric cutter, and adjust the eccentricity of the tool (a round-nosed one, Fig. 70, vol. i.) to the necessary extent to cover the surface to be cut, and bring up the corners perfectly sharp, so forming a true octagon base. It will require several successive cuts to accomplish this, and each facet may be completed separately, or the successive cuts may be taken seriatim by moving the dial-plate each time.

The foot of the urn will next claim our attention. A piece of ivory of suitable dimensions having been selected, it should be held in a jaw chuck, and turned out to the same size as the hole in the blackwood base. It is then rechucked on a boxwood chuck with a plug filling the hole, the face of the ivory being of course surfaced. For safety it is better to attach the ivory to the chuck with a little fine glue. This ensures its remaining true, and if the work is likely to be left unfinished for any length of time, it gets rid of its

Plate 5A.

liability to become released before it can be finished. While thus held turn the foot as nearly as possible to the desired form.

This subject affords an excellent opportunity of studying the capabilities of the universal cutter (Fig. 122), with which the various flutes are cut. In order to reduce the curve of the foot, so that it precisely coincides with the radius of the tool in the cutter, let the latter be adjusted as nearly as possible, both as to radius and position of slide-rest. This done with a horizontally revolving cutter, move the work slowly round by hand, regulating the depth and stop-screw of top slide for the penetration of the tool, until the true form is arrived at.

Now set the dial-plate with the index in the 96 circle, and make the first cut, or flute. This is effected by simply inserting the tool to a sufficient depth for a trial. Move the dial-plate by three holes and again insert the tool to the same depth, when it will be seen if the edges are brought up sharp. If not, a slight increase in the depth must be made, and so on by trial until in the two first flutes the penetration of the tool is decided. Be careful to fix the stop-screw, and then cut all round at every third hole, which will produce thirty-two flutes in all. It will be seen that these may be cut right out at each extremity, and, whenever this is the case, I much prefer the use of the fly cutter to that of the drill.

Above the series of flutes just completed we have a small plain bead, followed by a hollow, which is surmounted by a row of small beads ten in number, which are, of course, produced with a bead-drill. A second hollow succeeds these pearls, a small plain double hollow bringing us to the termination of the foot and stem, which receives the base of the convex curve which forms the lower portion of the body of the urn.

This piece extends as far only as the circle of beads. Select a piece of ivory the necessary size, turn out the recess to receive the upper portion, or body of urn. It will now be seen that the continuing flutes fit closely to the inside diameter of the beads. For the greater convenience of putting the parts together, wherever it is possible, the different fittings should be screwed.

While the ivory for the convex curve is held in the chuck, turn out the interior to a suitable substance, and cut a fine thread. This done, rechuck it by this screw on another boxwood chuck, and turn the curve by hand as nearly as possible to a hemisphere, leaving a rim where the beads are to be cut. This must be exactly the width of the bead-tool selected. Set the slide-rest parallel to the lathe-bed, and adjust the drill spindle to the precise axis of the mandrel, and cut a bead at every third hole of the 96 circle of division. Use an astragal-end drill, which, although it does not leave the beads quite so close together,

clears the divisions better, and is I think equally effective. It is not necessary to give dimensions, as the illustration is the size of the original, so that the measurements for a reproduction may be taken from it.

Our next proceeding will be to flute the dome, or hemisphere. For this we must requisition the dome chuck. It can, of course, be done with the spherical slide-rest, but as this instrument will receive full treatment in Vol. III. I will leave it for the present. If the chuck upon which the work is placed fits well, I do not think it will be necessary to resort to the interposition of a transfer. Place the dome chuck to hang vertically, and adjust the dome by movement of the right-angle arm until the tool will follow as closely over the curved surface as possible, first placing the tool horizontally in the slide-rest to the precise centre of the work.

Having correctly adjusted the chuck, replace the fixed tool by the drilling instrument, with a keenly sharpened round-nosed fluting-drill.

Observation of the specimen illustrated will show that the flutes terminate near to the beads with the curve emanating from the diameter of the drill, and also that each consecutive flute is exactly between the beads. To obtain this, care must be exercised, when adjusting the worm wheel of the dome chuck,

to bring the drill to the required position. This accurately accomplished, it only remains to move the worm wheel through three turns of its ninety-six teeth, which will divide each successive cut equally at the base, where it is fitted to the stem, which will be the top of the work while in progress. The drill may be carried throughout, but at the opposite extremity the work must be arrested in its traverse by the segment stop, which will require great care in its adjustment as to distance from the beads. If preferred, the worm-wheel and tangent-screw movement may be employed to carry the work round, but it is not at all necessary. I consider the work is equally good when the movement is governed by the hand, using care to keep the stop perfectly free from any obstruction. We see our subject growing step by step, and may proceed to the upper portion, which forms the body of the base or urn.

The ivory is first held while the inside is turned out and finished, and the base screwed to fit the part just completed. In order to reduce the possibilities of vibration, let the whole of the interior be fitted to a boxwood plug secured in a boxwood chuck. This is again fluted, and as it is not a very long job it will not require to be glued to the chuck.

The first thing to do will be to turn the external form to the finished shape, it will be seen that this is a

very slight curve. Call in the aid of the curvilinear apparatus as illustrated in Fig. 14, Vol. I., on the slide-rest. The template is, of course, shaped to meet the requirements of the design, the particular curve in this instance is so slight that no difficulty will be experienced in passing the cut over it in both directions. When turned, the drilling instrument is again used. A similar drill, but about $\frac{3}{100}$ larger in diameter, is selected. Here, again, we have thirty-two cuts, which are so arranged that, when the two parts are screwed together, the terminal point of each flute falls precisely in the centre of the space between the beads. As the drill is passed out at each extremity, the use of the fluting-stop is entirely dispensed with, the same number of cuts being required. It follows that the corresponding division must be used.

We pass now to the lid or cover, which is made up of three separate pieces. The first, as will be seen, overlaps the body, and the periphery is decorated with another series of beads, which, it will be noticed, are of rather less dimensions that those on the lower rim, and as the cover is, at this point, larger in diameter, it will take forty-eight beads to complete the circle. Before attempting this part, let the inside be turned to fit the rebate in the body. It is then rechucked while the outside is turned. First shape it by hand, and follow this by using the universal cutter set for the

tool to rotate horizontally. Adjust the radius, set in the cutter to make a complete curve, and move the work round by hand while the cutter is revolving at a high speed.

With the curve thus completed, set the dial-plate with the index on the zero of 96 circle, and make the first cut. Then move two holes, and make the second cut by careful penetration of the tool until the cuts are brought up to a sharp edge, when the desired depth is determined. Cut round the entire circle, which will produce, of course, forty-eight consecutive flutes. The beads will form the next proceeding, being executed in precisely the same way as those already described.

Surmounting this rim is a second concave curve, which is also cut with the universal cutter in exactly the same way, the two parts being screwed together. Succeeding this comes the finial, which, as will be seen, consists of a plain, highly polished hollow. Rising above this is a short cylinder. This is ultimately fluted with a step-drill, and carried to such a depth that its appearance is lightened and the small point rising to the apex completes a specimen that is well worthy of reproduction.

CHAPTER IV.

THE CURVILINEAR APPARATUS.

WHILE offering a description of this apparatus, it will not be desirable to occupy time and space by reference to it as originally made, it being obvious that since its introduction, more than half a century ago, it has been very much improved and more fully developed. It will now, therefore, be considered only in its latest form, with all the recent improvements.

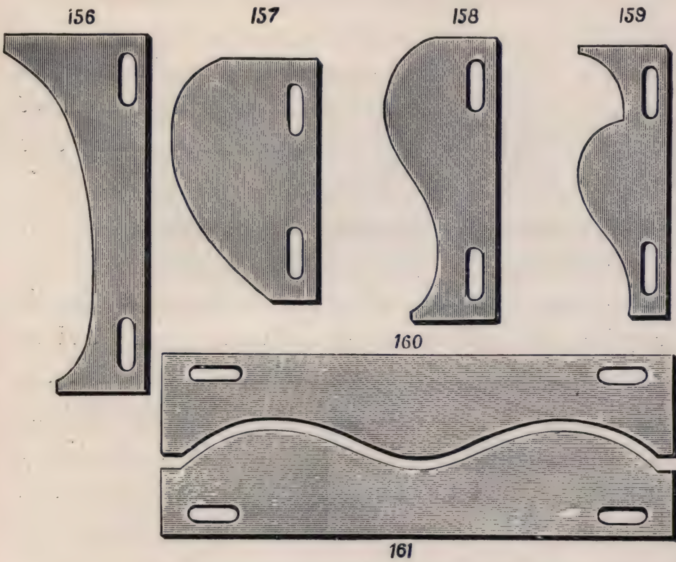
By reference to the engraving of the complete slide-rest (Fig. 14), it will be seen that the apparatus is mounted upon the main slide, and from the manner in which it is now fixed, as introduced by the author, no alteration in the construction of the rest is necessary, not even to the extent of drilling and tapping holes in the slide to receive the two screws which fix the standards to it. These it will be seen are attached in the same way as the fluting-stops, one angle being cast in the solid with the standard, while the other is fixed with a screw and steady-pin, so that it can be clamped

in any position, thus doing away with the holes in the face of the slide, which are, under any circumstances, a decided objection. On the top of the standards a steel bar is fixed, and is made about 1 in. shorter than the slide. A series of holes $\frac{1}{2}$ in. apart are drilled throughout its length and tapped to receive the screws which fix the templates to it, the guides also have the holes elongated to admit of increased adjustment laterally; the two screws that hold the bar to the standards are simply screwed into the latter.

A variety of templates or shaper-plates may be made, a few of which are illustrated by Figs. 156, 157, 158, 159, 160, and 161. They are made of steel in order that their precise form may be more accurately retained. Should, however, any special shape be required, which is often the case, sheet brass will answer quite as well. Some are made in pairs, which are employed to turn and decorate the bowls of tazzas or similar objects. Although, of course, any number of templates may be made, a limited supply will do a large variety of work, as, at times, a portion only of the curve may be used, the traverse of the slide being arrested by the fluting-stops when the exact distance is decided, that is, with reference to that portion of the curve to be applied in relation to the material to be operated upon. The way in which the standards are now fixed, and the bar being rather shorter than the

main slide, an additional means of lateral adjustment is accessible, without altering the position of the template on the bar.

The rubber forms a very important feature of this apparatus, and may be made in various ways; one



form is in the shape of a plain pillar, fitted at the base to the tool-box, having a small screw with a capstan-head fitted to the front, for the purpose of letting the tool forward for increased depth of cut. The top of the pillar is filed to a taper vertical wedge with a narrow edge to bear against the template. This form,

however, has been greatly improved upon by the introduction of that shown in Fig. 15, which is made similar to a small popit-head, and has a leading screw with milled head, by which a more convenient means of adjusting the depth of cut is obtained. It is composed of gun-metal, fitted at the base to the tool-box, and is fixed in position by a capstan-head screw, which binds it to the tool or cutter placed in the tool-box. At the top is fitted a small steel cylinder, the end of which is bored out to receive different rubbers, that seen in the engraving being the most effective. It is in the shape of a small roller, which as it passes over the undulations of the curve, performs its operation more smoothly; but as at times a narrow edge is required, the roller can be replaced by one, and to remove it the cylinder is wound in until the end of the leading screw pushes it out, after the manner of the ordinary popit-head. This particular form of cylinder has been found to be a very considerable advantage. The height of the cylinder is so arranged that the centre of the rubber takes effect upon the edge of the template.

As may be conceived from its name, the apparatus is employed to turn and ornament curved forms, which may be produced either on the surface or the cylinder, that is, with the slide-rest set parallel to the lathe-bearer or transversely across it, and the necessary

actions are supplied by the combined movements of the traverse of the main slide, and the oscillation of the tool-box, caused by the rubber being kept in close contact with the template by the lever, the bridle of the guide-screw being removed, and, as neither it nor the depth-screw are required, they should be screwed back out of the way. If either be left in contact with the pillars against which they generally abut, the true forms of the template will not be produced. Should a portion of the work be required of a cylindrical form, the stop-screw may be employed to prevent the rubber from reaching the curve.

When about to turn the form of any particular template, the material should be reduced in the first place to a plain cylinder the length required, and then as much as possible of the superfluous material removed by hand-turning, thus saving a considerable amount of wear to the edge of the template. When using the apparatus to finally shape the work, a fixed tool (Fig. 38) is the most useful of its kind to employ, as it is rounded at the point and cuts on the sides, which causes it to remove the material on either side as it ascends and descends the different curves contained in the template.

From the profile of many of the curves, it will be at once observed that the cut cannot at all times be traversed continuously in both directions. Fig. 159,

for instance, would require the rubber to be traversed from the largest diameter to the smallest, or in other words, downhill. If the cut is made in the reverse way, the depth of the curve will act as a stop and prevent further traverse in that direction. When the work is reduced to the form required, resulting from the template employed, it may be decorated by any of the revolving cutters. Fig. 1, Plate 6, is an example of the kind of work produced by the aid of the vertical cutter combined with the curvilinear apparatus, and is one of the most simple to execute. After the material has been roughly shaped by hand, the apparatus is mounted on the slide-rest and the template (Fig. 158) adjusted, and, with the round-nosed tool, Fig. 38, before alluded to, it is turned to the shape required. In the figure under notice, it will be seen that the resultant curve differs in appearance from the template. This is simply from the fact of its being reduced considerably below the diameter of the latter.

The material being thus shaped up, the fixed tool is removed and replaced by the vertical cutter; and here a very important adjustment is necessary. It will be noticed that the centre of the tool in the cutter presents itself to the work in a totally different position, and until this is corrected it will not follow the same course as the fixed tool that turned the outline; to adjust this a very fine pencil-line should be marked on

Plate 6.

the work, preferably, at the most prominent part, and at the precise centre of the fixed tool. This done the slide-rest must be moved bodily along the bed, until the centre of the tool in the vertical cutter coincides with the pencil-line; the slide-rest is then again clamped to the bed. It will now be found to traverse the same path as the tool it has replaced; the cutter is set to a radius of $\frac{8}{10}$, and the 96 division arrested at every 12 employed, giving eight segments. The exact depth of cut required is ascertained by trial, and the finishing cuts should always be made in the same direction; by preference from right to left. Work of this kind requires the support of the popit-head, while that of large diameter can be done without it, unless exceptionally long. The lateral adjustment of the slide-rest above alluded to will not be found at all a difficult matter, but will require care.

The universal cutter (Fig. 122), however, does away with the necessity for it, as the centre of the tool when clamped in the receptacle is coincident with the axis of the spindle which passes through the square stem; it will therefore represent the same centre as the fixed tool. This is the case whether set vertically or horizontally.

From a strictly theoretical point, the cutter, whether fixed or revolving, should equal in size the rubber that bears against the edge of the template, that is, for a precise reproduction of the curve employed. This cannot

at all times be so, and, although an alteration in the curvature of the guides will effect a facsimile, it is not considered necessary, as sufficient precision is obtainable without.

The variation is more observable when the cutter is set to revolve horizontally, and, the more the tool is extended with regard to its radius, the more perceptible will be the difference in the profile of the work when cut, especially at the larger diameters, either concave or convex, as that portion is nearer at a right angle to the axis of the material. For some reasons this cannot be deemed an objection, as many different curves may be cut from the same template.

Fig. 2 (Plate 6) is illustrative of the work produced by employing the drill, or, rather, both it and the vertical cutter. The same template was used; the form turned in precisely the same way as Fig. 1, leaving a projection at the centre of the concave portion; the fluting-stops were then adjusted to cut the flute the length required; a round-nosed drill, $\frac{10}{100}$ in. in diameter, was then placed in the drill-spindle and traversed from right to left until arrested at the desired points by the fluting-stops. Thirty-two consecutive cuts were then made; and the fluting-stops moved to decide the terminal points on the other side. The short cylindrical part was then cut with the same drill, the depth being ascertained by trial cuts just to

bring up the edges sharp; the vertical cutter then takes the place of the drill, and the rim round the centre cut into eight equal parts, the small end of the same figure being cut in a similar way. The flutes gradually diminishing in width at the smaller diameter renders most graceful lines.

Fig. 3 represents the results of the curvilinear apparatus used in conjunction with the spiral apparatus. This vase is made in two pieces, the body and foot being in one, while the top forms a separate part. When reproducing this, the form is first shaped approximately by hand, and finally with the templates (Figs. 156 and 157); the spiral apparatus is then arranged, and being fitted to the back of the lathe-head, the work is placed on the mandrel-nose, without the necessity for interposing the spiral chuck in front.

The wheels employed were 144 on dividing chuck on the mandrel, gearing into a pinion of 18 on the double arbor, a wheel of 120 on the same, gearing into a pinion of 20 on the socket below, acting the same as when geared to a wheel on the slide-rest screw, when the apparatus is fitted to the front of the lathe-head. The fluting-stops are adjusted to arrest the traverse on each side, but the latter should always be made in the same direction, as referred to in the chapter devoted to spiral turning. In the instance of the figure under notice, the cuts were made from right to left, terminating at

the small part of the figure. The tool is withdrawn and traversed back to the right-hand flutting-stop for each succeeding cut. The spiral chuck is then moved six divisions and the second cut made. The depth being decided by the two first cuts, it only remains to proceed in the same way entirely round the figure. The curves produced by this combination are very graceful, and may be altered to any extent by using different templates and varying trains of wheels.

To produce the top portion of this figure, the template (Fig. 156) was used, and it will be observed that the spiral grooves run in the reverse direction. The only thing necessary for this, is to place the intermediate arbor with a 30 wheel on it between the 144 and the 18, the gearing in other respects being precisely the same. It is, of course, needless to say that figures of a similar class may be produced, with spirals crossed in both directions; the result of this being a series of square or diamond-shaped pyramids, the precise figure of the same being determined by the twist or pitch of the spiral.

CHAPTER V.

THE ECCENTRIC CHUCK.

THE eccentric chuck may be considered the first of the series of ornamental chucks, and for the simple face or surface patterns, its productions are similar to those produced by the eccentric cutter. With the chuck the patterns are cut with a fixed tool in the slide-rest, and the eccentricity obtained by the slide of the chuck being set out from the centre, according to the pattern desired, and the radius given to the tool by the main screw of the slide-rest, the amount determined by the number of turns or divisions of the micrometer, the worm-wheel in front of the chuck forming the necessary means of dividing the cuts equidistantly.

With the eccentric cutter the radius is obtained by the movement of the tool-carriage from its centre, and the eccentricity by a corresponding adjustment of the slide-rest; the division-plate on the pulley being used for the subdivision of the work. The two are frequently used in combination, both for surface patterns and for the ornamentation of solid forms of various

characters, by which very beautiful and curious effects are produced.

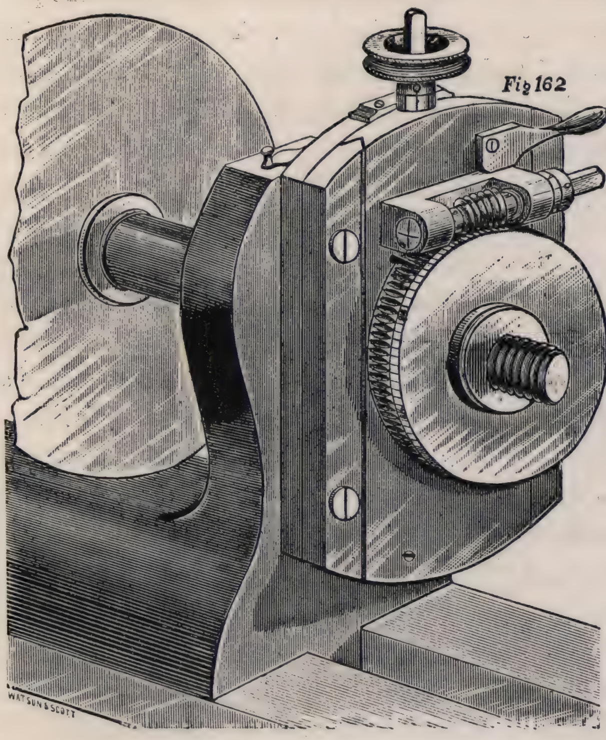
It has been suggested by numerous influential patrons, that a preliminary explanation of the manufacture of the various chucks will be of interest, especially to those amateurs whose inclination and time are devoted to making tools, and it is hoped that the details which the author has great pleasure in publishing, will also render the mechanical actions of the various apparatus more intelligible.

The eccentric chuck illustrated by Fig. 162 is seen in a vertical position to the lathe-bearers; and when the back plate is screwed to fit the mandrel-nose, it should be so adjusted by turning off the face that bears against the mandrel, in order that it may assume this position when the index-point is placed in any one of the starting-points on the arc on which the divisions are drilled, also the adjusting nut of index midway on the screw. The object of the latter is to admit of the more accurate adjustment of the chuck, by elevation or depression of the index, whichever is required.

The front face of the plate is then turned true and flat, and a small hole about $\frac{1}{16}$ in. in diameter drilled in the centre for the convenience of centering the front plate to it, which also has a hole drilled in it the same size. The steel double chamfered bars should be either planed or filed up in one piece and separated afterwards.

The front plate should then be surfaced, and the angular grooves planed out.

The bars must then be fixed to the back plate by



two steel screws, the front being the first to fix. The two plates are placed together with a small pin fitting into the holes in the centre, which gives their approximate

position in one direction. The bar is then placed against the V-groove, in which it is to work, and held parallel to the side of the chuck, while the position for the holes to receive the screws are marked, thus giving the position for the first or front bar. The centre-pin is then removed and the opposite bar fixed in the same way. The front one should have, in addition to the screws, two steel steady-pins, fitting tightly into the steel and passing into two corresponding holes in the metal plate. The object of these is to prevent any movement, which would destroy the axial truth of the chuck when completed. The off side is provided with two set-screws, the heads of which project so that the steel bar can be set up to the slide in the plate. The holes in this bar are elongated to allow it to move forward with the pressure of the set-screws. The reason for placing the latter on the off side, is to leave the front free from obstruction, as it is often required when using a square to set the chuck to the position seen in the engraving.

The two plates should not be in contact, but fit only between the angles of the bars. When the slide is thus far fitted and parallel, it may be well worked together with a little fine oilstone powder, but not under any circumstances should emery of any kind be used. When finally corrected, the front plate should be set as near central as possible, and the hole to receive the steady-pin drilled. This, it will be seen by the engraving, is

indicated in the lower left-hand corner, the hole is broached slightly taper from the back, the pin being well fitted. It is generally placed in this position, as it is more readily removed, and less in the way; the pin projecting at the back is not seen.

The chuck should now be placed on a true surface-plate by the side opposite the set-screws, and the necessary centres for drilling the hole to receive the main screw obtained. This is done with a scribing-block set to the centre, and a line marked across each end. This, with the division of the two plates, will give the centres. The hole, which is $\frac{1}{2}$ in. in diameter, is then drilled from the top to about 1 in. past the centre.

The chuck must now be taken apart, and the top end of the front plate cut out to receive the nut in which the main screw is to work, and by which the slide is actuated, the recess is made with a circular cutter about $\frac{5}{8}$ in. in diameter, and $\frac{3}{4}$ in. long, sunk into the half of the hole drilled to admit the screw, the second half of which is in the back plate. The nut is simply a short cylinder of a corresponding size to the cutter; to ensure its accuracy it should be turned on the main screw, it is then soldered to the recess so that the screw will lie perfectly parallel with the face of the slide.

The screw in this, as in all other chucks, must be

ten threads to the inch; a shoulder about $\frac{3}{4}$ in. in diameter is left on it when forged, which is fitted to the recess countersunk in the top of the back plate, and is retained there by the coupling in front of it, fixed by two screws. The main screw has a square filed on its end to receive the micrometer, which is fitted to it, and pinned across to prevent it coming off when the chuck revolves at speed.

It will now be discovered that the nut, from the extra diameter necessary to fit the recess, will not slide in the back plate, it must therefore be reduced on the projecting side to pass freely in the semi-circular groove, which is in the back plate, and is practically the second half of the hole drilled for the main screw. The nut is reduced with a file, care being taken not to remove more than necessary, and to see that it works quite freely up and down the groove; the metal bearing is then fitted to the top of the back plate, by which the main screw is kept in its place. Thus far the slide and screw may be considered complete, and the worm-wheel and tangent-screw will form the next part to proceed with.

The wheel has ninety-six teeth, and is cut first with a single-tooth cutter, set to an angle in the universal cutter-frame to correspond with the rake or pitch of the screw; this is inserted about half the depth of the thread. The single-tooth cutter is then replaced by a router or

hob, which is a counterpart of the screw itself, and is fluted to cut like a master-tap. The cutter-frame is then set perfectly vertical, and the wheel cut up to what may be termed a full thread, the hob or cutter being worked gradually into it. The metal turning slide-rest (Fig. 18) is the most suitable to employ for such a purpose. The correct diameter for the wheel is 3·18, and the pitch of the screw ten threads to the inch. This the author has now adopted in preference to that of 9·45, and it may be said that the latter is gradually becoming obsolete.

The chuck should now be carefully put together, with the steady-pin in its place, and the projection on the front plate turned accurately to fit the recess in the back of the wheel. This is a most important point, the ultimate truth of the chuck to a certain extent depending upon it, both diametrically and facially. This done, the slides must be taken apart and the front plate carefully rechucked by the fitting, and there is nothing better for this purpose than a well-seasoned piece of boxwood. A recess is then turned out sufficiently deep to allow the screw-head and washer, that hold the wheel in its place, to go below the main screw, which passes over it when the chuck is finally put together. The recess should be about 1 in. in diameter and perfectly true, the wheel having to turn evenly between the front face and bottom of the recess. Any

inaccuracy will cause the wheel to be free during one part of its revolution and tight at others.

The steel frame to hold the tangent-screw is made from a forging of the required shape, and has a pivot on one end, which is fitted to a hole in the front plate, so that the screw, when placed in gear, is square across the front of the chuck and tangental to the wheel. The hole in which the pivot of the frame is fitted is then countersunk at the back to receive the head of the screw that holds it. The screw is fitted tightly against the end of the pivot, so that the frame may move round without undue freedom. The end of the tangent-screw is then filed square to receive a metal micrometer, which is divided into eight equal parts, also for the convenience of using a key or winch-handle to adjust the wheel to the division on its periphery.

The screw being frequently thrown out of gear, a steel spring must be fitted into a mortise hole in the front plate, under the flange of the wheel, so that its point will press against the under side of the frame at the end where the micrometer is fitted. By this it will be seen the screw is kept out of gear with the wheel, so that it can be turned to any division required. To replace the screw in gear, a steel cam, made as seen in the engraving (Fig 162), having two flat sides and a rounded edge, is held to the plate by a screw, in such a position that the curve will throw the frame into gear,

and the square edge hold it firmly, and when turned the reverse way, the spring operates on the frame and releases the tangent-screw. The cam has a short projection for the thumb to press it either way. This particular action was designed by the author in place of the plain eccentric with a long lever, as sometimes made, and found to be in the way. In that now illustrated, there is no possible chance of the cam being unintentionally moved when the work is in progress.

For the convenience of reading the division on the periphery of the wheel, two steel indices are fixed in the front plate, one just below the micrometer, and one on the opposite side. Each of these agrees with the divisions on the wheel, so, that whatever position the chuck may be in, the reading may be taken with equal facility. The wheel is divided at every tooth with figures at every 6 and a mark at every 3, the micrometer being, as before stated, divided into eight equal parts.

A portion of the front plate, at the top, above the cam, is filed away to form a straight line, and from this the back plate is divided at every turn of the main screw to agree with the micrometer on it, which is divided into ten equal parts, and again subdivided—having in all twenty equally divided lines, capable of reading to two-hundredths of an inch.

The lines on the face of the back plate are at all

times more convenient for denoting the amount of eccentricity given to the slide, when a complete turn of the screw is required.

The front wheel is sometimes made in the form of a ratchet, having also ninety-six teeth, with a detent and spring. This, for patterns requiring the process of double counting, is preferred by some amateur turners, but it has many defects: one in particular is, that if the chuck that holds the work receives any undue pressure, it becomes fixed, and the force required to remove it causes the detent to slip out and the wheel to move round, thus destroying, or at least damaging, the teeth; to avoid this, a steel pin may be placed under the detent. The worm-wheel, however, may be said to have entirely superseded it, since, by the aid of the cam and spring, the screw is conveniently placed in and out of gear when the wheel is required to be partially revolved, and it has also greater facilities for subdividing the work by the micrometer on the tangent-screw; the ratchet-wheel is therefore seldom made.

Having thus detailed the process of manufacturing this chuck, and, as previously stated, determined to pass over the group consisting of mere fine-line surface ornamentation, the more interesting subjects, comprised in compound solid figures, both of a simple and complex nature, to be executed by this chuck, will form the matter for the following chapter.

CHAPTER VI.

CYLINDERS DECORATED BY THE ECCENTRIC CHUCK.

It is possible with the eccentric chuck alone to produce some very beautiful designs, but when used in co-operation with others, such as the ellipse and dome chucks, more elaborate works are produced, and many references will be made to them in describing the specimens contained in the plates, some of which may be deemed worthy of reproduction.

Plate 7 contains a few examples of ornamented cylinders of the first series or type of decorations as applied to this particular form, and it will be noticed that in some instances the result is simply a number of discs placed eccentrically one to the other, which particular formation is generally known as the geometric staircase, and may be made extremely useful in many ways. Others are more or less of a spiral form, the pitch or twist being varied by the increased eccentricity of the slide, and alteration in the movement of the dividing wheel; the width of the tool employed also exercising great influence over the result.

This particular style of work may also be applied to the tubular cylinder, which, for many kinds of work, is most beautiful. The effects of it will be seen by reference to Figs. 3, 4, and 7, and in this, as in the solid figure, there is practically no end to the variety.

To reproduce Fig. 1, the work is held in a small metal cup chuck and mounted upon the nose of the eccentric chuck. It is then turned to a perfectly true cylinder rather less than 1 in. in diameter, the end being faced off also perfectly flat and true, the latter proceeding being necessary for it to receive the centre of the popit-head, all work of any length requiring its support.

The slide of the eccentric chuck is then moved out one turn of the screw, the wheel of the chuck is set to 96, and a fixed tool $\frac{5}{100}$ in. wide employed in the slide-rest. When adjusting the tool previous to starting the pattern, care should be taken that it is set to the desired point, when the zero of the micrometer agrees with the reading line on the end plate of the slide; any of the divisions may be employed as a zero, but it is likely to confuse the operator in the various movements. It is therefore better to make a rule of starting from 0; should the two points not agree, the slide-rest may be moved bodily along the bed of the lathe till they do, but the adjustable micrometer obviates any necessity

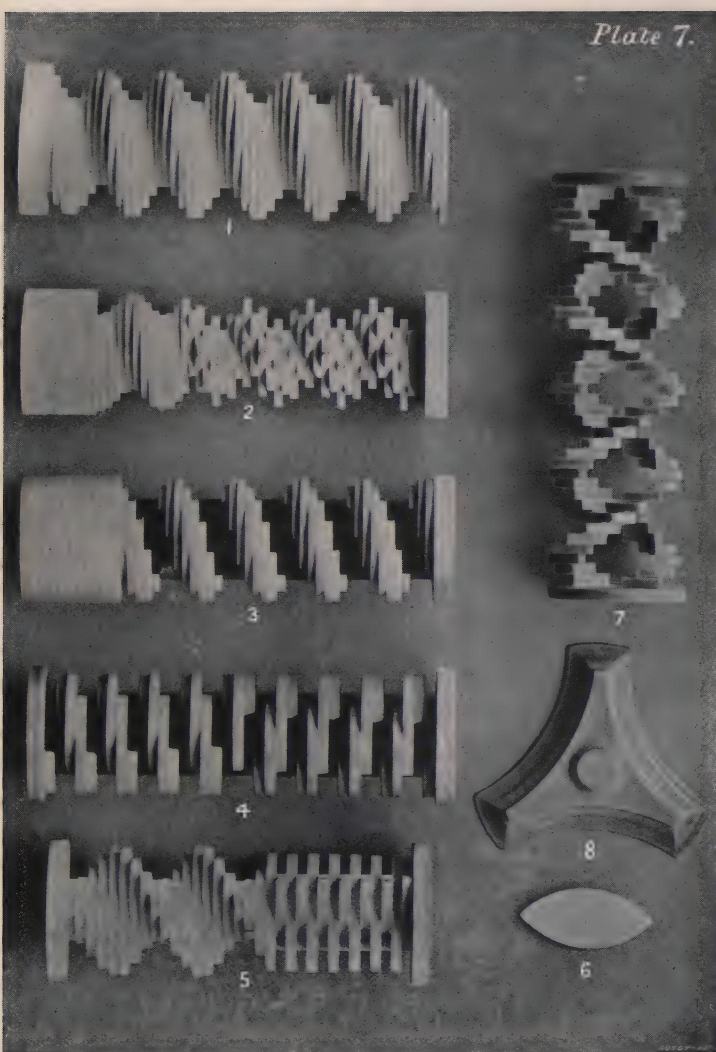


Plate 7.
1
2
3
4
5
6
7
8

for this trouble, and may be at once set to the required point, irrespective of the lateral position of the tool. The slide of the chuck being moved out, and all the other settings arranged, the popit-centre should be placed in contact with the work to prevent vibration, and the first disc turned, the tool is gradually advanced until all the eccentricity is removed and the material at that point again reduced to a concentric state $\frac{3}{4}$ in. in diameter; the stop-screw of the top slide is then fixed, which will determine the depth of cut and consequent diameter of each succeeding disc. The tool is now moved exactly its own width by one half turn of the main screw, or $\frac{5}{100}$ in.; the popit-centre is withdrawn, and the wheel turned towards the operator twelve divisions; the centre is replaced and the second cut made, and it only remains to repeat these movements throughout any length of material that it may be desired to ornament. Thus the settings are: the movement of the tool precisely its own width, the dividing wheel twelve divisions forward, the eccentricity of slide remaining the same for each cut, the popit-centre being withdrawn while the wheel is turned, and replaced before each succeeding cut is attempted; the end of the material will therefore have eight consecutive centres. This will be found anything but a difficult operation, and forms a very interesting study indeed.

Fig. 2 was cut in precisely the same way, but is

smaller in diameter ; a few of the original discs are left on the end to show this. Having cut through the desired length in this way, the fixed tool is replaced by the vertical cutter with a tool of the same width, and adjusted very carefully to cut over the same surface ; the tool is set out to a radius of $\frac{7}{10}$, and the work held stationary by the index in the division-plate. The tool is then advanced, so that when cut at every quadrant of the dial-plate, the corners of the disc are left sharp, each one representing a square with slightly concave facets, and, it will be observed, entirely altering the appearance of the work. This style of decoration may be varied in many ways by the employment of bead and figured tools in the vertical cutter.

Fig. 3 represents a still further variation. The ivory is first bored out to a $\frac{1}{2}$-in. hole and fitted on to a hardwood plug, mounted on the eccentric chuck ; it should be carefully fitted, and fixed with very thin glue ; the exterior is then turned to a true cylinder, $\frac{13}{16}$ in. in diameter. The slide of the chuck is then moved out one turn, or $\frac{1}{10}$; the width of the tool in the slide-rest is $\frac{5}{100}$, and the dividing wheel moved twelve divisions for each successive cut ; that is, the first cut is made with the slide-rest set at zero, and the wheel at 96. For the second, the tool is moved precisely its own width by the screw of the slide-rest, which will require one half turn, and the wheel moved forward twelve divisions, and

the tool penetrated till a true circle is turned; this process is repeated throughout the length required.

When the work is finished the wood plug can be removed, and at times this is not altogether unattended with difficulty. To dissolve the glue, it should be soaked in warm water; but the wood having a tendency to expand, it sometimes creates a risk of breaking; this, however, with care and patience is overcome. Having removed the core, the hole may be filled either with an ivory polished cylinder, or blackwood, the latter being very effective, as seen in the illustration.

Fig. 4 is a still wider extension of this particular style of decoration, being cut half its length in each direction, right and left. The settings for this particular figure are as follows:—The hole is bored out $\frac{1}{2}$ in., and the external diameter left $\frac{7}{8}$ in., the tool being $\frac{7}{100}$ wide, and the wheel divided into four. The object of this alteration is to illustrate the difference in the twist of the spiral, caused by the diameter having only half the number of discs cut on it. Having adjusted all the different settings, the tool is made to penetrate just deep enough to again turn a true circle; the tool moved precisely its own width, and the wheel moved one quarter round. This is repeated one-half the length from the popit-head towards the mandrel; arriving at the centre, the wheel is moved in the reverse direction, which causes the twist to turn in the opposite way.

It will be observed that the spiral form of Fig. 3 is more distinct and appreciable. This beauty is lessened in Fig. 4, consequent upon its having, as before intimated, only four discs in place of eight, in one complete turn. It is not exhibited as a form of beauty, but simply to more clearly define the two results obtained by this means.

Fig. 5 shows another distinct variation. The chuck is moved out to $\frac{4}{10}$ eccentricity, the tool $\frac{7}{100}$ in. wide. The first cut is made at 96, the tool made to penetrate deep enough to cause the termination of the cut to pass out each side at the centre of the diameter of the cylinder. The wheel is then turned round to 48, or the exact half, and a corresponding cut made; the shape of that part left by this process is seen by Fig. 6, which is intended to show the result of the two consecutive cuts. The tool is then moved precisely its own width laterally, and the corresponding incision made with the wheel set to 24 and 72. These operations, it will be seen, have been repeated alternately along a portion of the cylinder.

The remaining half is again cut differently, the same tool and equal depth are employed, consequently the form of the discs is still identical with those previously cut, and the only difference in the settings for the production of this part is, that the wheel is moved six divisions forward, the second cut for each being made at the opposite side, thus: 96 and 48, 6

54, and so on. This movement of the wheel, it will be observed, causes the work to take a spiral form, which may be varied in a number of different ways.

By reference to Fig. 7 it will be seen that a still further advance is made in the application of the eccentric chuck, and although very much more beautiful in effect, it was cut in precisely the same way as the preceding one. The only thing necessary to create the double strand spiral form, as seen, is to bore the ivory out to a tube. The following details, although in some measure a repetition, will not be out of place:—The ivory was first bored out to a tube with $\frac{1}{2}$-in. hole, it was fitted to a boxwood plug in a metal chuck, and then mounted upon the eccentric chuck, the cylinder was then turned to $\frac{7}{8}$ in. in diameter, the tool exchanged for one exactly $\frac{7}{100}$ in. wide, the slide of the chuck moved out $\frac{4}{10}$, by four turns of its main screw, the dividing wheel set to 96, and the first cut made; this is repeated with the wheel turned half-way round to 48; the tool is then moved laterally exactly its own width, the wheel moved forward six divisions, and cut again; the wheel is then turned to the opposite number, which will be 54, and the second cut to complete the figure made; by this it will be seen that each consecutive disc requires two separate operations, and by moving the wheel six divisions for each one, an elegant spiral is formed, which may be varied

like Figs. 3 and 4 in endless different ways, either by increased or diminished eccentricity, or more or less movement of the wheel, the width of the tool employed having also again considerable influence over the result.

This specimen, as will be noticed by reference to the plate, is also cut in two directions, that is, half with a right-hand twist, while the other is in the opposite way. The first, or that nearest the popit-head, is formed by the wheel being turned towards the operator, for the reverse, the wheel is moved the opposite way.

Patterns of this character may be varied to a large extent by making a certain number of cuts each way, that is to say, eight or ten, with the wheel moved from the operator, the same number being repeated with the wheel turned the other way; these alternate movements create so many complete parts in the two directions, thereby destroying the spiral twist, but with a result which may be considered equally beautiful.

Such work may also give more trouble in removing the wood core, which is occasioned by the delicacy of the parts, and the tendency of the wood to expand. When the plug is removed, the tube may be filled with either an ivory polished cylinder or, if preferred, black-wood, each giving great finish to the appearance of the work. Left open, as seen in the illustration, it is sometimes more effective, as both sides of the work are visible, but should it be intended, as a pedestal, to

support any other object, its strength will be increased by the interior being filled.

To illustrate all the different forms to be produced on a cylinder by the movements referred to, would necessitate a large number of plates; the foregoing remarks will, however, show the manner in which to proceed, and it is hoped enable those who read them to not only reproduce, but to improve upon them.

All works operated on by this, or similar chucks, should be placed on hardwood cores that have been previously driven into metal chucks, as those composed of wood only are likely to move round on the nozzle of the dividing-wheel, and thus destroy the accuracy of the work; as the slightest alteration in this respect will be detrimental, it should be made a rule to use nothing but a metal chuck.

We have now considered the application of the eccentric chuck as applied to the decoration of cylinders. It is also much used to shape and embellish compound solid forms of many distinct characters; surface solids, for instance, are shaped in many ways, Fig. 8 representing a simple and effective base in the form of a curved triangle with moulded edges. The material for this was first roughly shaped, and surfaced on one side, by which it was glued to a true surface on a chuck attached to the eccentric chuck. It was then reduced to the desired thickness and polished, the slide of the

chuck moved out to $1\frac{1}{2}$ in. eccentricity, and the radius of the fixed tool set to the necessary distance to leave the terminals the desired width. The drilling instrument is then placed in the tool-box with a moulding-drill, the latter is made to revolve at a high speed, and the work moved partially round by the left hand, or, preferably, by the worm-wheel and tangent-screw of the segment apparatus. Having cut the three concave curves of the triangle, the slide of the eccentric chuck must be returned to the centre, and the steady-pin replaced. The drill is then set to a radius suitable to the diameter of the material, and by gradual penetration the same figure cut on the ends, which will mitre at the corners and form a very elegant finish. Such moulding may be made to form an entirely different figure by employing the division and index, and cutting seriatim, the space for each cut being determined by the movement of the division-plate, the formation of the pattern depending upon the figure of the tool employed.

Many examples of this class of work are contained in the different forms of claw-footed bases, of three, four, six, or practically any number of feet, which are arranged by dividing the worm-wheel to the number required, and adjusting the radius of the tool to suit the same, duly considering the external diameter of the material. Many such forms are to be executed with the eccentric cutter, the work being placed on the

mandrel-nose; or, for further combinations, on the eccentric or other chuck of a similar nature, in which case the various curves may be operated upon with the revolving cutters to effect further decorations than can be obtained with the eccentric cutter only.

When the work is mounted on the chuck that may be selected, either eccentric or rectilinear, the combined right-line movements of it and the slide-rest admit of the production and decoration of solid forms composed of curved and straight lines together, and by this arrangement both curious and beautiful results are obtained. A deal of unnecessary changing of tools is saved by using the moulding tools similar to Figs. 82 to 93, which may be equally well applied in all the instruments. At times, however, it is desirable to use a series of separate tools to effect the same purpose, as it is not always possible to place the eccentric cutter in contact with the work, in consequence of the projecting right-angle slide. These are points that the nature of the work and the particular tool employed will lead the operator to decide which is the most appropriate.

CHAPTER VII.

THE ELLIPSE CHUCK.

THIS has, for some reason not yet explained, been commonly known as the oval chuck. It is entirely wrong to call an ellipse an oval. The latter is a distinct figure, shaped like an egg, being wider at one end than the other. An ellipse has two unequal diameters, the longest being the transverse or major axis, the short one the conjugate or minor axis. Reference will be made to these as the major and minor axis.

The details necessary for the manufacture of this chuck are similar to those embodied in the description of the eccentric chuck, but with further additions. That now under notice is illustrated by Fig. 163, and is the latest pattern, containing all the most recent improvements. It will be observed that the front worm-wheel and tangent-screw are in every way the same as in the eccentric chuck.

In the present case, the V-grooves are planed in the back plate, which is screwed to fit the nose of the mandrel, and is the narrow one. The double chamfered

steel bars are fixed to the front or broad plate. Two steel pallets are then fixed across the back of the chuck, being attached to the steel bars, and set-screws are provided to adjust them to their relative positions in reference to the movable ring upon which they operate.

The sliding ring, which is cast in the solid with a metal frame, is attached to the face of the headstock by two steel centre-screws, the points fitting into corresponding centres in the headstock, and when fitting up the frame, it should be chucked by the centre hole and the ring turned inside and out; it is then rechucked by the periphery of the ring, and the back turned as far as the projecting bosses through which the centre-screws pass will allow; it must be then surfaced, and the holes tapped to receive the centre-screws. It is necessary that these holes should be in a parallel line with the face, and, to ensure this, the holes are tapped with a tap having a long plain pin turned to the size of the bottom of the thread, the plain part entering one hole, while the tap itself cuts the thread in the opposite one. The screws should be parallel and well fitted.

To fix the frame in its position on the head, it must be temporarily placed on a metal plug on the mandrel-nose by the centre hole, and set square across the face; by which process the centres are obtained, and when marked, the ring is removed, and the holes drilled and

countersunk to correspond with the points of the screws. When countersinking the holes, they should be placed so that the screws, when tightened, will draw the frame firmly to the face of the head.

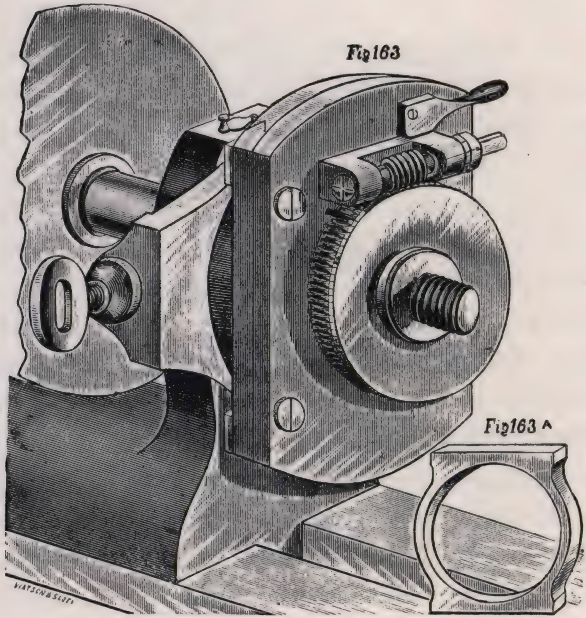


Fig 163

Fig 163 A

When the metal plug is removed, it is very probable that the ring will be found to have slightly deviated from actual concentricity to the axis of the mandrel; to correct this a cutter is used, and this is fitted into a chuck made for the purpose, and is set down on to the

ring as required, the mandrel being rotated slowly by hand until the ring is again cut perfectly true.

The top of the metal frame is then filed perfectly level with that of the head, and before moving the ring, a line must be carefully marked square across both, to denote the position for the purpose of replacing it at any future time; the centre hole is then elongated to allow the ring to be adjusted to the necessary eccentricity, a graduated scale, 1 in. long and divided into twenty equal parts, is then engraved on the top of the frame from the zero line previously marked.

The movement of the ring from the centre is governed by the two centre-screws, which, being radial, draw the frame transversely across the face of the head, the front screw being released and the opposite one screwed up a corresponding amount. The off side of the frame should have a set-screw fitting through the side of the boss, so that when the ring is moved, which it often has to be, the centre-screw may be fixed, and the front one only released, thus ensuring the return of the ring to its original position, this can, however, be readily determined by the division on the frame. By the engraving, it will be seen that the screws are made in the shape of thumb-screws with elliptical heads, and when the ring is fixed, the pressure of the hand is sufficient to secure it. It is not desirable to use a lever, except with the utmost caution, as an overdue

strain is likely to spring the plate, and destroy the accuracy of the ring.

When adjusted by the division on the frame to zero, the pallets should be carefully set down to bear upon the ring. The simple revolution of the chuck will then have no effect, but when the steady-pin is removed and eccentricity given to the ring, the revolution of the steel pallets round it will cause the slide to oscillate, thus combining a straight line and rotary movement, which produces an ellipse, and the difference between the two axes will be as follows:—The minor axis will be twice the amount of the radius given to the tool by the slide-rest, and the major axis the same, with twice the eccentricity of the ring added.

So far we have the mechanical principal of the ellipse chuck, but in following a course of ornamental turning, it will require manipulating in various ways. A few examples of the combined movements of it and the slide-rest will be of service in further illustrating its powers.

The number of varied patterns to be produced by the application of this chuck to face work, by shallow fine lines grouped and arranged by the different adjustments, is without end. The primary movement will be at once understood by the few woodcuts which have been prepared with reference to the movements of the chuck for the necessary degrees of

difference between the two axes, and the position of the figures.

Fig. 164 illustrates the result of the following settings: The slide-rest set at right angles to the mandrel, and a double angle tool (Fig. 26) of 50° fixed in the

Fig. 164.

tool-box. The tool is then set precisely to the height of the lathe axis; it is also set correspondingly accurate, transversely. The sliding ring of the chuck is then set out $\frac{6}{10}$ and the tool moved to a radius of $\frac{7}{10}$. The first cut is then made very shallow, and the depth screw

adjusted. The eccentricity of the ring remains unmoved, and the successive cuts are made at every turn of the main screw of the slide-rest; and when the point of the tool is returned to the centre, it cuts a straight

Fig. 165.

line. It will be observed that the ellipses in this figure are all parallel to one another.

Fig. 165 may be said to be the opposite in character, and requires the movements reversed; the slide-rest still set in the same position, the radius of the tool identical, and for each successive cut the eccentricity

of the ring is reduced $\frac{1}{10}$, the tool remaining in the same position throughout. This shows clearly that only the reduction of the eccentricity decreases the difference between the two axes of the ellipse, and when the ring arrives at zero, or concentric to the

Fig. 165A.

axis of the mandrel, a plain ring is cut. By these two figures we have clearly defined the two opposite movements, namely, the reduction of the radius of the tool only, in the first instance, which produces a series of parallel ellipses terminating in

a straight line, and the decrease in the proportion of the figure at the major and minor axis by the corresponding reduction given to the eccentricity of the ring alone, terminating in a concentric ring at the final cut.

Fig. 165A shows the result of the two movements employed in combination, by which a series of ellipses are cut of equal proportions. Reference to the following instruction will show that this figure is produced with equal facility: The slide-rest in the same position, the eccentricity of ring $\frac{5}{10}$, the radius of tool $\frac{7}{10}$ for the largest ellipse, and for each successive cut, reduce both equally, and when the ring is concentric to the mandrel a circle is again the result.

Fig. 165B illustrates the use of the dividing- or worm-wheel on the front of the chuck, which may be employed to produce an unlimited number of beautiful line patterns. This particular group being, as before stated, practically passed over, only those that are required to show the movements of the chuck will be illustrated, and Fig. 165B, it will be seen, has a series of ellipses standing at right angles to each other. In this instance, the ring had an eccentricity of $\frac{5}{10}$, the radius of the tool being adjusted to the same amount; the worm-wheel set to 96 for the first cut, which is the largest of the series; the wheel is then turned to 24 to place the next ellipse at right angles to that already

cut. It will be observed that if the wheel is turned to 48, the same course is again travelled as when it is set to 96, consequent upon the equal movement of the slide of the chuck on each side of the centre.

Having cut an ellipse with the wheel set respec-

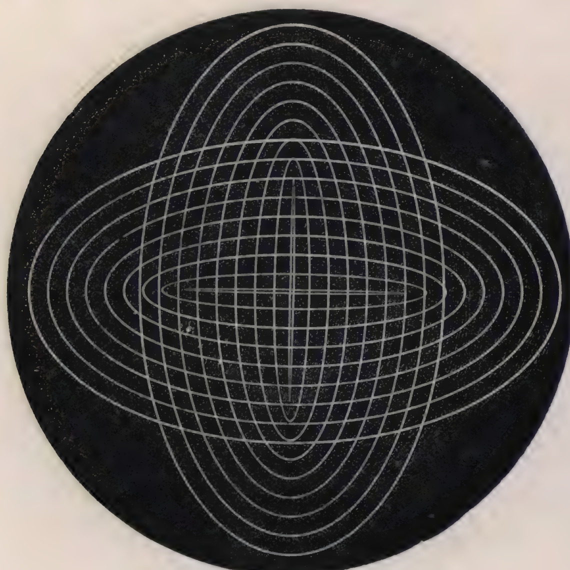


Fig. 165B.

tively at 96 and 24, the radius of the tool is reduced by one whole turn of the screw of the slide-rest for the second, so that for every turn of the screw the wheel is held alternately at the two numbers, indicated by the figure on the periphery of the wheel. The latter may

be divided into almost any number, as previously stated, by which complicated patterns are executed; but the more simple illustrations, as in Fig. 165B, are better adapted to clearly show the movements required for its manipulation.

Fig. 165C.

Fig. 165C is an example of employing the ellipse and eccentric chucks in combination, by which the figures are placed in various positions, that illustrated being quite a simple example, at the same time fully showing the movements and adjustments required. The

two chucks are also largely employed in the shaping and decoration of compound solid forms.

The ellipse chuck is placed on the mandrel-nose, and the eccentric chuck upon it, adjusted to stand perfectly parallel one to the other; the sliding ring is then set out to $\frac{5}{10}$ eccentricity, the radius of the tool to $\frac{6}{10}$, and the first, or largest, ellipse cut. The slide of the eccentric chuck is then moved out $\frac{1}{10}$ by one turn of the screw, and the radius of the tool reduced a corresponding amount by one turn of the slide-rest screw; these two movements being carried out for each cut, result in the figure seen, which is similar to the ordinary shell-pattern cut with identical movements of the eccentric cutter and slide-rest; the two adjustments being equal, cause all the cuts to pass through the same line at one extremity.

By these movements in conjunction with the front dividing-wheel, which, as already stated, facilitates the adjustment of the ellipse to any angular position, as seen by Fig. 165C, unending variations may be made. The few examples will, however, suffice to illustrate some of its powers, and enable amateurs to prosecute their researches further.

When practising ornamental turning with this chuck, there are several points in its manipulation found by practical experience to be of great importance, which, being referred to here, will be of valuable

assistance, more especially to those uninitiated in such work.

First then, it is necessary in ellipse turning to use a slow motion, as a quick speed causes such vibration that the chuck, from its oscillatory movement, cannot perform its function correctly; secondly, a metal chuck should always be used in place of one composed of boxwood, the latter being likely to turn round upon the screw of the wheel if it receives undue pressure during its preparation. Should this occur, the angular position of the ellipse will be changed; the deviation, if discovered in time, may be rectified by the worm-wheel and tangent-screw. The use of the metal chuck, however, will prevent this, and it should therefore be employed in all cases. Thirdly, and a most important point to consider, is the centering of the tool to the axis of the mandrel, and any tool in the slide-rest, that is substituted for another, must be carefully tested to see that it is identical in this respect with the one it has replaced.

Work of a large size, that from its unequal surface will require considerable reduction, such, for instance, as an ivory hollow suitable for the body of a box or other purposes, will be more easily brought to a smooth surface by using the metal turning slide-rest (Fig. 18), with a strong tool or cutter-bar fixed in the tool holder. Works of more delicate nature may be

operated upon with the ornamental slide-rest with a satisfactory result. In turning out a deep recess with the latter, the cutter-bar (Fig. 20) will be found of valuable assistance, as a continuous cut may be taken with the main screw in place of a series of consecutive incisions with the top slide, when set at right angles to the lathe axis. The capacity of the depth screw is also insufficient for work of large size.

The sliding ring should always be removed during the process of reducing the material to a concentric state, the steady-pin being then in its place; if the ring is allowed to remain on, the steel pallets revolving continually round it in the same position become worn in the centre, but when the ring is set out to even a small amount of eccentricity, the pallets have a lateral movement, which causes the wear to be equalized; and when from constant use they are free, the adjusting screws will set them down on to the ring again; it is also essentially necessary to keep both well lubricated.

The supplementary ring (Fig. 163A) is a very considerable improvement to the ellipse chuck. It will be seen that it admits of a broader surface bearing for the pallets to slide on, instead of working only on the periphery of the metal ring, to which the steel ring itself is fitted, giving a smooth and even action to the slide, thus preventing any tendency to vibration whatever; the wear to the ring and pallets is also

minimized. The advantages of this introduction will be so apparent that no further details will be required.

To follow the style of Grecian architecture, by the employment of semi-elliptical arches, will be found useful in the construction of temples, clock-towers, watch-stands, etc., and will be found a most interesting study, and, by the combined movements of the ellipse and eccentric chuck, aided by the segment apparatus, may, without difficulty, be produced, and subsequently ornamented to a varied extent, either by continuous mouldings, or by numerous consecutive cuts, the work being arrested for each by the index, or segment apparatus, while the depth screw of the slide-rest determines the penetration of each. In some instances the front dividing-wheel is employed for a similar purpose.

When decorating elliptical cylinders, the various positions in which the work presents itself to the tool during its rotation must not be lost sight of. Having adjusted the eccentricity of the ring and reduced the material to the desired form, the fixed tool may be replaced by the drilling instrument, the chuck is then set to a vertical position, and, the drill being radial to the axis of the tool, will cut equally deep on each side of the centre at the opposite points of the major and minor axis.

As the chuck is partially rotated for the next cut, it will be observed that the upper portion of the quadrant

of the figure comes in closer proximity to the tool than the lower, thus cutting deeper, and the variation of each cut will be found to increase in this respect until nearing the major axis, when it decreases, eventually cutting equally when the ellipse stands horizontal to the lathe-head, thus presenting the major axis radial to the tool. Continuing the process, the cut will be seen to be deeper on the reverse side of the following quadrant, gradually again decreasing till the minor axis is reached, when the depth of cut will be found to be coincident with the first. Of course, the larger the amount of eccentricity given to the ring, the greater the difference in the above respect will be. The deviation is not so detrimental when a plain round-nosed tool is used, but when a bold moulding tool is applied, it will destroy the contour of the figure entirely.

All the revolving cutters are more or less applicable to the ornamentation of the elliptic cylinder, the vertical cutter and drill-spindle, however, are generally used, and are most to be recommended. The universal cutter is also of great service, especially when the ellipse chuck is used in conjunction with the spiral apparatus, which it can now be, with the author's arrangement of the latter to the back of the lathe-head, suggested to him in the first place by General G. C. Clarke, who is acknowledged to be one of the best amateur turners of the present day, and this particular arrangement of the

apparatus is universally approved of and admitted to be superior in all ways. It will be found fully explained in subsequent chapters especially devoted to it.

So far we have considered the various instruments as applied for the ornamentation of the elliptic cylinder, it will now be necessary to give here a brief outline of their employment for the same purpose on the surface, and the illustration of the miniature or photograph frame (Plate 8) will suffice to show more clearly the result of their various adjustments.

When about to make such a frame, the first thing will be the selecting of the material; and in doing this it may be mentioned that it is not necessary that it should be of any definite proportion, unless for any specific purpose. It must be cut from the hollow end of a tusk. This done, a piece of well-seasoned boxwood is driven firmly into a metal cup chuck, and turned as short as possible, it is then faced over and the ivory glued to it. The sliding ring is now adjusted to suit the proportions of the material, so that it may be left as large as possible. The rebate at the back is then turned out to receive the picture and glass; this should be about a quarter of an inch deep, and quite half an inch larger than the aperture, so that a good face is left for the picture to bear against. It may now be removed from the chuck by being soaked in warm water to dissolve the glue.

A second chuck is then turned to fit the rebate, and again glued to it. When fitting it, care should be taken that the chuck is exactly the depth of the recess, so that the face of the ivory will bear against it, the inner pattern being cut through at each penetration, as seen in the illustration.

The slide-rest must in all cases be employed in turning ellipses, and such a frame may be roughed into shape by using both the main and depth screw in conjunction, the lever of course being dispensed with, and the top slide placed under control by the bridle; thus, by working both hands together, curves, either concave or convex, and mouldings of any shape may be worked up approximately. The fixed tool must then be replaced by the revolving cutters.

In proceeding to ornament the frame now under our notice, the horizontal cutter is the first of the revolving cutters employed, having in it a double quarter-hollow tool (Fig. 98), set accurately to the centre, the slide-rest is set parallel to the lathe-bearers, and the 192 circle arrested at every hole, thus creating one hundred and ninety-two consecutive cuts. The tool is inserted sufficiently deep to bring the points up sharp, and passed slowly over the part to be cut; the slide-rest is then turned to an angle to bring the tool to the centre of the following concave curve, and the horizontal cutter replaced by the drilling instrument, having in it

a round-nosed fluting-drill $\frac{25}{100}$ in. wide. By reference to the illustration, it will be seen that the incisions made by the drill are in the centre of the points left by the horizontal cutter, and in order to adjust the work to place them thus, it is necessary to use the adjusting index, for the reason that, having been cut at every hole in the division, there is no half to set the index to for this purpose. The work is moved round by the adjusting nut of the index to the desired position, and fixed by the lock nut; the drill is then made to penetrate deep enough to leave each cut the exact width of the points left by those preceding it.

When the division employed can be equally divided, the adjusting index is dispensed with, and it is only necessary to move the plate round to half the number taken for the first cut, and continue as before. The object of explaining this, is merely to give an instance of the service of the adjusting index.

The projecting beads will be the next part to proceed with, and it will be seen that these are equally divided, and as this was accomplished without special apparatus, a few hints in connection with it will, it is hoped, be of value. There are forty-five consecutive beads. When turning that part of the work on which they are to be cut, it should be left rather wider than required, for the purpose of future adjustments, if found necessary; the ellipse chuck is then set perfectly

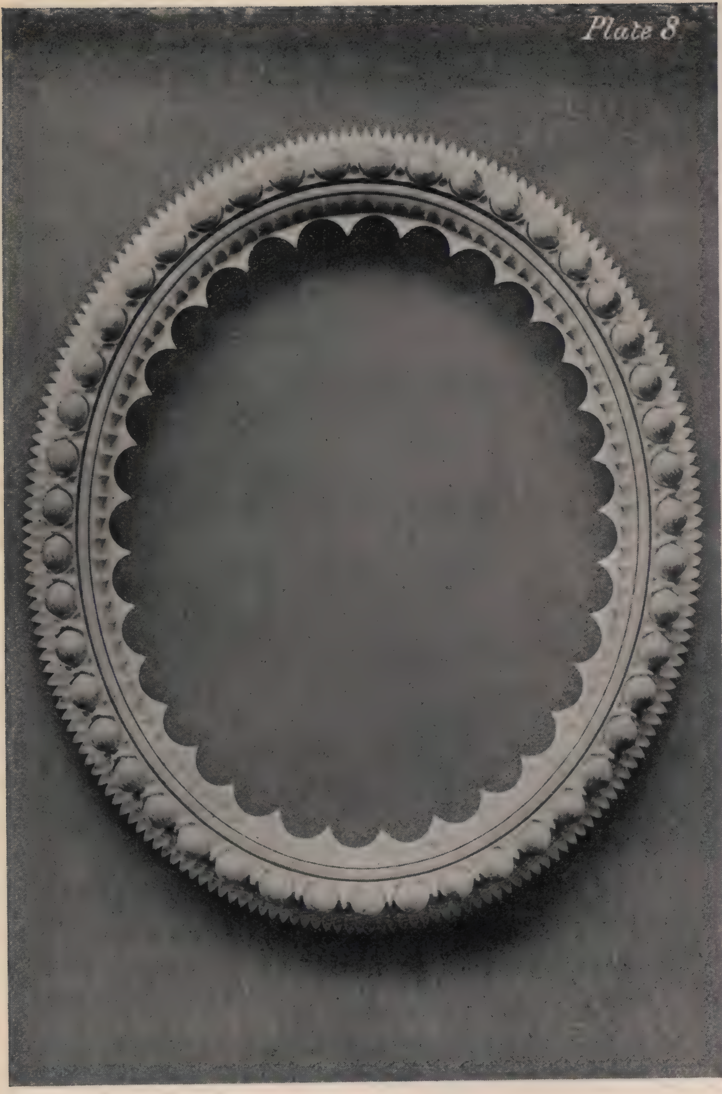


Plate 8

vertical by the segment apparatus, which also affords the means of equally dividing the work; the drill-spindle, with a bead-drill $\frac{25}{100}$ in. wide, and astragal at the end, is then set to the centre of the lathe axis, which is, of course, the same as the tool previously employed, and is arranged to cut also in the centre of the space left to receive the beads; the drill is then inserted very lightly, only in fact to disclose its extreme diameter; the work is then moved round by the tangent-screw of the segment apparatus until the edge of the drill comes exactly in contact with that of the previous cut. This trial of distance should be carried entirely round the work, and in all probability it will be found that the space will be either too great or insufficient for the last bead; the error being discovered before the beads are cut, it may be corrected in the following way:—The drill is moved either to or from the centre, according to the deviation, and it is for this compensation that the part on which the beads are to be cut should be left wider than required. The substance of the method is simply this:—Supposing the entire surface, from the centre at which the drill is set, will not hold accurately, say, forty-five beads, by extending the radius of the drill to a larger diameter it can be made to do so, and by exercising care, the result is perfectly satisfactory; by using a drill of rather less dimension the same object is attained. It

may be mentioned that these means would only be employed in the absence of the legitimate apparatus, which is specially made for the equal division of the ellipse, and will be fully explained in the following chapter.

The beads are all cut in the first instance with the drill set radial to the surface, the astragal drill is then replaced by a pointed one of the same size, and as the beads, when finished, are more like a ball than a hemisphere, the top slide must be moved round by its quadrant to an angle, so that they may be undercut, the adjustment of the slide must be the same on each side of the centre, and the drill also set to its desired position, by the main screw of the slide-rest. The projecting points between the beads are the result of the angle on the point of the drill, and not a second operation; a small round-nosed drill is afterwards inserted between the beads, on both sides.

The plain continuous bead was cut with a fixed tool, and to turn this correctly, with a really polished surface, the chuck must be rotated slowly, and the penetration be slight and even. If once the tool is allowed to cut roughly and unevenly, considerable difficulty will be experienced in getting it quite smooth again. This is most important, as work of this class must be left untouched from the tool, except to be polished with whiting on a brush.

The following seriated moulding was cut with a large quarter-hollow drill, inserted at every hole of the 96 division. There are two ways of placing the drill in contact, either by the depth screw of the top slide, or by moving it laterally by the main screw of the slide-rest, which is arrested at every cut by a fluting-stop.

For the final pattern on the inside, the eccentric cutter was employed, having in it a narrow parting tool, $\frac{3}{100}$ in. wide, fixed at a radius of $\frac{3}{20}$, and passed entirely through the ivory on to the boxwood, the same means for the equal division being adopted as for the beads, viz. the segment apparatus. Care should be exercised when cutting through work of this character, as there is some liability of the extreme points breaking off, the result of which would be, the destruction of many hours' labour. The present subject may be considered complete, and although a comparatively simple example, it is both effective and useful.

Various other references will be made to the combined uses of the ellipse chuck and revolving cutters, as applied to the specimens in the various plates, but the foregoing are sufficient to illustrate its capabilities in this respect.

CHAPTER VIII.

COMPENSATING INDEX FOR THE EQUAL DIVISION OF THE ELLIPSE.

This instrument forms a most valuable addition to the lathe, and by its aid all works executed with the ellipse chuck are rendered more perfect and beautiful in effect. Reference has been made to the equal division of the ellipse in the details of the miniature frame illustrated in Plate 8 in the preceding chapter, which gives sufficient evidence of the advantage of a mechanical means of effecting the same purpose, and the following details, combined with the very clear and distinct illustration contained in Fig. 166, will, it is hoped, render the whole apparatus easily understood. Although it may be considered a difficult instrument to manufacture, it is comparatively easy to manipulate, and, as now fitted by the author on an improved plan at the back of the lathe mandrel, as suggested by the Rev. C. C. Ellison, it is more perfect and convenient in every way, and forms a distinct apparatus, being removed intact from the mandrel when not required for

use. When fitted to the front of the driving-pulley in the original way, the two discs and wheel have to remain on the mandrel, which is a decided objection, the wheel having a tendency to catch in everything that it comes in contact with, and also to collect dirt, shavings, etc.

A metal sleeve, to which is attached in the solid a dial-plate 7 in. in diameter, is fitted to the mandrel in the same way as the dividing chuck of the spiral apparatus. On the sleeve two discs are fitted, to which radial arms are attached, so that they work as if hinged thereto. The arm at the back, or nearest the dial-plate, has an index-point fixed to it, as seen in the engraving, which moves up and down with the arm when in action. The second radial arm is held stationary by a steel blade, the lower extremity of which is fitted to the arm of the spiral apparatus, the top of the blade being slotted, and open at the end, so that the binding screw may be passed into it, by which it is fixed in the desired position.

To obtain the required motion, a wheel of sixty teeth is fitted to the sleeve in front of the arm. This wheel is provided with the means of adjustment in either direction, and is fixed by three screws, the holes through which they pass being elongated, so that when finally set, the screws can be tightened by a key. A second wheel of sixty teeth is then fixed to the radial arm, to

revolve and gear with that on the sleeve. This is also geared to a wheel of thirty teeth, which is attached to

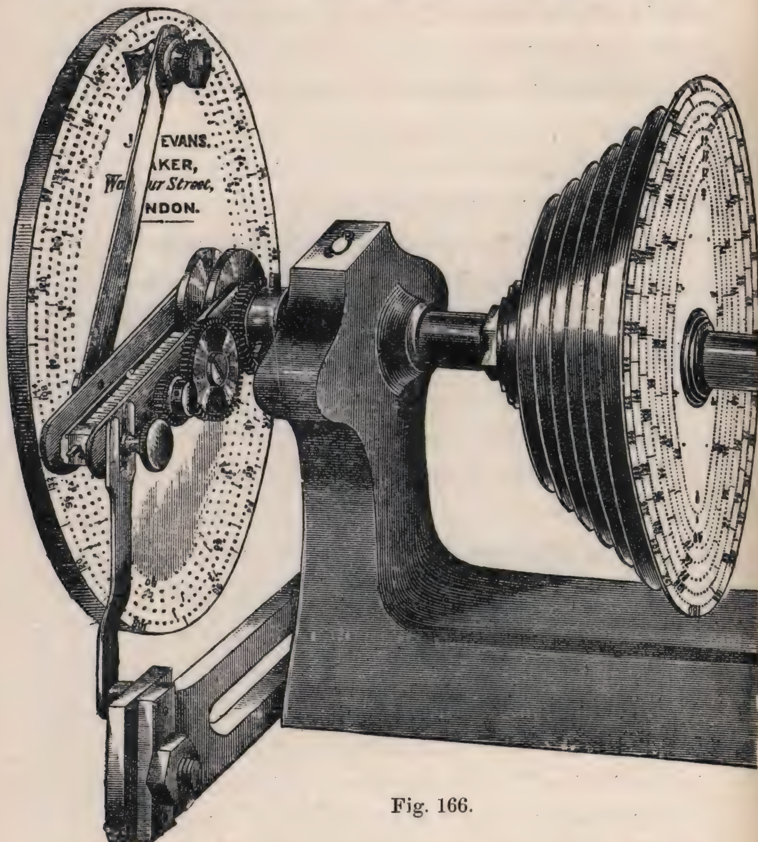


Fig. 166.

the axis of a slide that revolves between the two radial arms. The nut of this slide is actuated by a screw of ten threads to the inch, which has a micrometer on its

end, and passes through a steel stud, which works in an oblong slot in the arm nearest the dial-plate; on the top of the slide a scale, divided into twentieths of an inch, is engraved, the zero being precisely opposite the axis of the wheel that has thirty teeth. When the index is set to this point, and the mandrel rotated, the slide between the two arms simply revolves, while both arms remain stationary, but when the nut is moved towards the mandrel, it carries the stud in the arm with it; the consequence of which is, that the arm moves up and down with the revolution of the mandrel, the exact amount being determined by the eccentricity given to the nut of the slide. When fitting up an instrument of this kind, the work should be so far completed as described; it is then set up on its place with the slide and index precisely radial to the mandrel, when the ellipse chuck is standing in a vertical position, as seen in Fig. 163. When thus adjusted, the two arms and slide will all be in parallel lines, and once made, this adjustment is permanent and will not require further attention.

The index in the arm nearest the dial-plate is then used to describe an arc on the plate, from which the zeros or starting-points for the divisions are drilled, thus enabling any one of the several circles to be employed without any further adjustment. The top of the index is provided with the means of altering the

position of the pointer, if for any reason it should be found necessary, but, the divisions being drilled with the starting-points on the arc, the point may be transferred from one to the other, in the same way as the index to the division on the pulley-face.

When fitted to the lathe in this way, the whole apparatus may be removed in one piece, and, when replaced for future employment, it only requires to be set perfectly radial to the mandrel. This is simplified by marking a line on the lower blade, to correspond with one on the metal radial arm to which it fixes, the lower arm in which the blade is held at its base may also be placed at the same distance, by which the re-adjustment of the apparatus is more readily effected than when fitted to the front, and it is clearly and distinctly the most convenient method to employ for such an instrument.

When adjusting the index for use, it will be necessary that its movement should correspond with that of the ellipse chuck, and in whichever position the chuck is set, either vertical or horizontal, the slide between the arms must be radial to it.

The slide must be set parallel with the line on the arms, when they are attached to the discs on the sleeve, and, if the ellipse chuck does not stand precisely vertical, the 60 wheel on the sleeve may be released and the mandrel rotated till it does, when the wheel is

again fixed. The eccentricity to be given to the slide of the compensator will depend upon the difference between the two axes of the ellipse, and may, of course, be altered to suit the material.

It has been found impossible to give any definite rule by which the movement of the eccentric ring of the ellipse chuck may be governed by that of the compensator, for the reason that the radius of the tool in the slide-rest has considerable influence over it; therefore absolute accuracy can only be obtained by trial. It may be mentioned, however, that all ellipses of the same definite proportions will be found to require the same amount of eccentricity in the slide of the compensator. The following table of adjustments will give a few of the approximate settings, showing the amount of movement necessary to the slide, for various proportions of ellipses :—

Proportion of ellipse.	Movement of slide of compensator.
5 to 6	1¼ turn
4½ to 5½	1½ turn
4 to 5	1¾ turn one division
3½ to 4½	2 turns one division
3½ to 4½	2¼ turns
3 to 4	2¾ turns
2¾ to 3¾	2¾ turns
2½ to 3½	3 turns
2¼ to 3¼	3¼ turns one division
1¾ to 2¾	3¾ turns
1½ to 2½	3¾ turns
1¼ to 2¼	4½ turns
1¼ to 2	5 turns

These will be sufficient to illustrate the movement of the apparatus, and it must be pointed out that a very slight deviation in the proportion of the ellipse will necessitate a readjustment of the slide, according to the variation in the figure.

Fig. 165D will perhaps still more clearly demonstrate the advantage of equally dividing this class of work. The shells cut round one portion of the ellipse, it will be seen, are all cut equidistantly, and were done in the

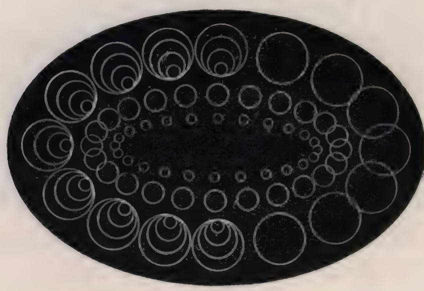


Fig. 165D.

following way :—The apparatus, Fig. 166, placed on the back of the mandrel, as seen in the engraving; the ellipse chuck set vertically, and the slide of the compensator set radial, and held by the thumb-screw to the lower steel blade; the index-point then placed in the zero of the 192 circle on the dial-plate of the compensator, and the slide between the two radial arms moved towards the mandrel $3\frac{1}{4}$ turns, the eccentric cutter placed in the slide-rest, and the tool moved to

a radius of $\frac{3}{10}$. The dial-plate is then moved to every 12 for each consecutive cut, so that if carried throughout the figure there would be sixteen consecutive circles; the radius of the tool is then reduced $\frac{5}{100}$, or half a turn of the screw, and the slide-rest moved a corresponding distance for the second circle.

The latter movement of the tool nearer to the axis of the work creates a further difference in the proportion of the ellipse, and will therefore necessitate a readjustment of the slide of the compensator, the same being required for each alteration of the distance to or from the centre. The shells are thus equidistantly placed round a portion of the figure, the remaining space being left, so that the result of employing the stationary index may be more clearly portrayed. By referring to the print (Fig. 165D) it will be seen that the circles become gradually nearer to each other as they approach the major axis, while the difference is increased in the opposite direction as the minor axis is neared. To cut the seven plain circles above alluded to, the chuck is again set vertically, and the tool in the eccentric cutter returned to the same radius as employed for the first series—the 96 circle of division on the pulley-face also used—and arrested at every sixth hole.

This deviation in the proximity of the cuts is perhaps more clearly illustrated by the two inner circles of smaller rings, which, from the increased difference between the two axes, are more distinctly visible.

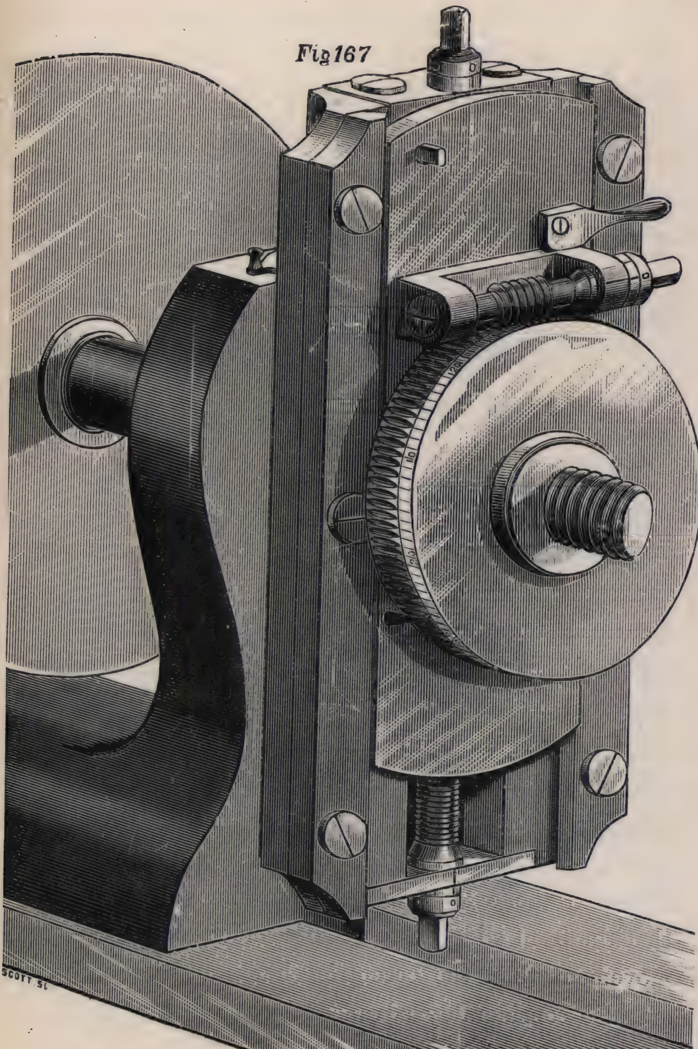
CHAPTER IX.

THE RECTILINEAR CHUCK.

THIS chuck in its improved form may be said to have entirely superseded the straight line chuck, which, from its inability to perform a rotary movement, is limited to work of a straight line character only, and although a necessary adjunct to a rose-engine, and usually supplied with such a tool, is seldom made to the modern ornamental turning lathe, therefore its construction may be passed over, being of small interest to those who study the art, and practise the same, with the modern apparatus; and as the chuck illustrated by Fig. 167 is one of the most important, and will perform a rotary and straight line movement in combination, it is rendered of considerable service for the ornamentation of compound solid forms, all the various instruments being used in conjunction with it, according to the results desired.

It may be classed as an extra large eccentric chuck, and its process of manufacture is similar to it, with exceptions and additions. The body of the chuck is

Fig 167



planed up and surfaced, it is then held on a true surface chuck, and a recess turned in the back, $1\frac{1}{4}$ in. in diameter, $\frac{1}{4}$ in. deep, this is for the purpose of receiving a supplementary or false back, on which it is held during its progress in manufacture by four strong steel screws. The back is sometimes cast in the solid with the plate and screwed to fit the mandrel-nose; either way is equally true. The particular advantage of the false back is found in the fact that the chuck can be made in the absence of the lathe-head on which it is to work, except for a few hours while the back is fitted. A standard steel chuck should be made for the purpose, which ensures its ultimate accuracy.

When fixed to the back a light cut must be taken over the surface with the slide-rest set perfectly true, and the steel double chamfered bars then fixed, as described for the eccentric chuck, but with three screws in each, instead of two, on account of the extra length of the bars; the front plate is then adjusted, and the slide ground up. The steady-pin is then fitted, being placed at the top of the plate, the lower end being reduced as much as possible, in order that the slide may be extended as far from the centre as possible.

From the extra length of the chuck it is obvious that the front slide is capable of a much more extended movement than the eccentric chuck, and its facilities are also considerably advanced by the slide moving to

each side of the centre. When it is set vertically, it will move two inches above, and three inches below the centre, thus creating a vertical traverse of five inches.

The main screw, like all others, is ten threads to the inch, and is carried through the entire length of the chuck, having a coupling at each end; a separate steel collar being fitted on one end to form an equal bearing with the other; both ends are then squared to receive a key and a micrometer. The latter are both divided from corresponding zeros into ten equal parts. This improvement was introduced by the author, and its advantages will be apparent, as the slide can be moved with equal facility from either end, so that when, during the progress of cutting various patterns, the chuck assumes such an angular position as to render it difficult to manipulate the slide from one end, it can be worked from the opposite; and the micrometers being coincident, the setting can be read from either. This arrangement of the screw is admitted to be superior to the short one, movable from the top only, and adds much to the value of the chuck. When used in conjunction with the segment apparatus and revolving cutters, it becomes in reality a shaping machine, and many examples of beautiful work, such as Gothic arches, moulded bases, and polygonal figures, are easily produced.

The front worm-wheel must now be fitted, and, unlike the eccentric and ellipse chucks, it has one hundred and twenty teeth. The tangent-screw and frame in other respects are the same, also the cam for actuating it, the wheel being divided on the periphery at every turn of the tangent-screw, and figured at every 10, with a dot at each 5.

MANIPULATION OF THE RECTILINEAR CHUCK.

Although to a certain extent resembling the eccentric chuck, the rectilinear chuck has distinct advantages, which consist in its extended capacity, and the traverse of the slide on both sides of the centre, and, being a stronger tool, it carries the other chucks with less tendency to vibration; it is seldom used in complete revolution, except while the work is turned true upon the wheel, being generally fixed in a vertical, horizontal, or angular position, and retained so by the segment apparatus, and it is when held at such an angle that the screw-head cannot be readily got at, that the advantages of the screw working from either end is apparent. It is largely employed in cutting and decorating compound solid and polygonal figures of any number of facets, etc. A few words upon the manner in which it is manipulated will assist amateur turners in working out its capabilities. As an example, we will assume it

is required to cut a square base 3 in. wide, with a thickness of ½ in.: the chuck is set to a vertical position, the slide-rest parallel with the lathe-bed, the eccentric cutter (Fig. 62) is placed in the tool-box, but the eccentricity need not be extended beyond what is necessary to cut out the width of the base; the cutter is then revolved at speed, and the work moved above and below the centre by the main screw to cut out the length of the square; the wheel is then moved round thirty divisions, or one-fourth, and the second side cut, the remaining two sides of the square receiving the same treatment at 60 and 90 respectively. The work, thus roughly shaped, may be moulded into endless shapes, and to effect this, various means are used: first, the moulding tools (Figs. 82 to 87) may be placed in the eccentric cutter; secondly, a moulding-drill may be employed, also, the different tools may be placed in the vertical cutter (Fig. 95), or the universal cutter (Fig. 122), set to cut in various positions.

To cut out a bold concave curve at the base of a square pedestal or similar object, the horizontal or universal cutter, set to cut horizontally, will be found a ready means to employ; the tool is set out to the radius required, and revolved at a high rate of speed, the work being carried up and down as before, with the slide of the chuck.

The variety of mouldings, as before stated, are

practically without end, and a very effective result is found in the same being pierced seriatim, the cutter revolving as before, but the work held stationary, and moved by the main screw of the chuck to the required distance for the succeeding cuts, the figure resulting being dependent upon the nature of the cutters used for the purpose. The slide-rest, set transversely across the lathe-bed, affords the opportunity of producing a large variety of patterns upon the face of the work, and many may be composed of curved and straight lines in combination.

In the latter instance, having cut the straight recesses the required length, for which purpose a square-end drill, sharpened on both sides, is employed, the eccentricity of the slide is adjusted so that the convex curves terminate at their extremities, and the partial rotation of the mandrel is arrested each side by the segment stops.

The production of Gothic arches also forms an important feature in this tool, and they may be executed on a large scale, their formation and decoration with the various moulding tools being also practically unlimited, either by continuous moulding or seriated cuts at intervals, decided in some instances by the partial rotation of the mandrel under the influence of the segment apparatus; at other times the movement is under the control of the dividing

wheel or slide-rest, either by lateral or horizontal movements.

The formation of large boxes or caskets, of square or oblong shape, by being put together, is also an interesting study, as the sides may be elaborately decorated by the combination of curved and straight recesses; and for such work the different pieces of which the box is composed will represent simply flat plates, which are glued to a surface while being operated upon; and for this it is preferable to use a metal chuck with a large surface of wood attached to it, as it is most important that the work, having been once set to the position, either vertical or horizontal, should not be liable to move on the nozzle of the chuck.

By reference to Plate 9 it will be observed that the rectilinear chuck may be employed for another and still more important branch of turning, which is, the cutting of convex curves round cylinders, and the result of such work, it will be seen, so closely resembles rose-engine turning, that it is generally supposed to be such by those who have not been instructed in the use of the chuck for such work. This particular pattern was designed and turned by the late Earl of Sefton, and in reproducing the example the following instructions will assist the turner, and lay the foundation of a class of work that may be enlarged upon to a very considerable extent.

A piece of ivory $2\frac{3}{4}$ in. long, and 3 in. in diameter is turned out perfectly true inside, and lightly glued to a boxwood chuck or plug; the exterior is then turned to a true cylinder, when mounted upon the wheel of the chuck. The latter is then set horizontally, and fixed by the tangent-screw of the segment apparatus; the slide is moved out from the operator to sufficient eccentricity to describe the curve that will be contained in the thickness of the material; the drilling instrument is then placed in the slide-rest, with a square-end drill sharpened on each side. That used for the present example was $\frac{16}{100}$ in. wide. The segment stops are now arranged so that the partial rotation of the mandrel may be carried in each direction, in order that the drill may cut entirely through the ivory into the wood plug, and in this process great care is necessary to avoid breaking away the ivory as the cut passes out.

Having by two trial cuts determined the position of the segment stops, the succeeding cuts may be made with the hand on the pulley by which its movement is governed; but the safest plan to adopt is to rotate the mandrel by the tangent-screw, as it is more certain in its motion, and not so likely to cause a fracture to the drill or work.

The same process is performed six times, the driving wheel being turned round twenty divisions for each cut; for the second series, the drill is moved by

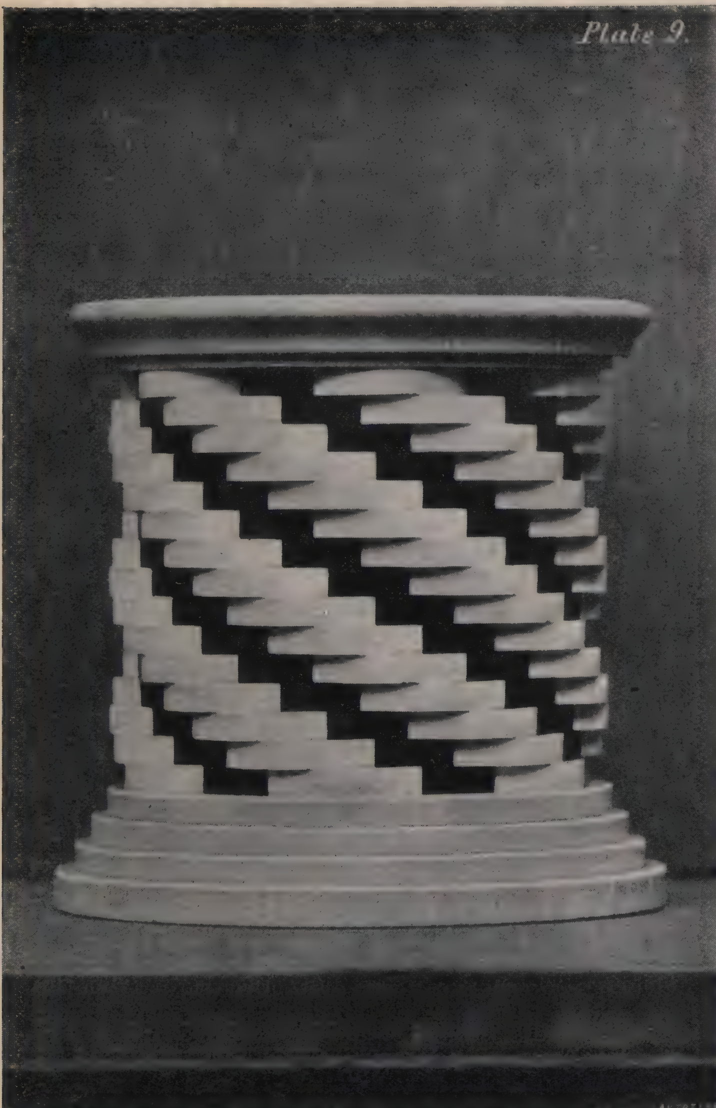


Plate 9.

the main screw of the slide-rest precisely its own width; the wheel of the chuck turned round five divisions, and a cut made at each 20 of the wheel from that point, and this process is continued throughout its whole length, resulting in a series of segments of circles being placed round a cylinder in a spiral form, and when the inside is filled with blackwood or other material, it forms a most effective pattern. The amount of twist contained in the spiral may be varied according to the movement of the wheel for each succeeding series.

The foregoing description is of a pattern which may be varied in many ways. Work of the same class may be carried out on a similar object without being cut through, and the formation of the curves is not confined to a spiral twist. For example, suppose a cylinder of ivory the same size is to be cut into similiar curves, but not through, nor in a spiral line. This being the case, the space occupied by the drill passing into the wood plug, as in Plate 9, may be usefully employed, and dispersed amongst a greater number of curves around the cylinder. The following few remarks will at once illustrate this description of work, the manipulation of the chuck being in many respects similar.

In the first place the chuck is set horizontally, and the necessary eccentricity given to the slide, the

dividing wheel set to 120, a drill of the same description, but $\frac{10}{100}$ in. wide, employed; the segment stops arranged to allow the mandrel to rotate past each side of the centre, and the trial cuts made. This pattern will require rather more care than those that are cut through, and the first cut must only be allowed to penetrate towards each end of the curve, without touching the extreme diameter of the cylinder. The tool must be gradually advanced by the guide-screw of the top slide, and it may happen that this proceeding will clearly indicate that some alteration in the eccentricity of the slide is necessary. This is a matter that is important, and may be readily effected, and when so adjusted, and the necessary depth is decided by the stop-screw to complete the curve, the remaining cuts of the first circle may be finished at every ten divisions of the wheel, leaving twelve consecutive curves in all. The drill is now moved its own width by one turn of the main screw, the wheel moved five divisions, or half the distance, and the second circle of curves cut in the same way, at every 10. It will be seen that this movement will equally divide the cuts, so that each alternate series starts from the centre of that preceding it, the result being, that instead of a spiral formation, the curves range in a straight course throughout its length.

There are many points connected with the working

of this chuck that will be at once apparent to the operator when using it. In such a pattern as that last described, it will be found that the curves do not meet absolutely, and, when this is the case, a projection is left at the termination of each cut, formed by the curve contained in the diameter of the drill; this adds, rather than detracts from the general appearance of the work; long taper forms are very handsome when cut in this way, and for such specimens it is necessary to support the end of the work by the popit-head centre, which must be removed each time before the wheel is turned round, and carefully replaced before the succeeding cut is made, in the manner referred to in Plate 7, descriptive of work executed on the eccentric chuck.

CHAPTER X.

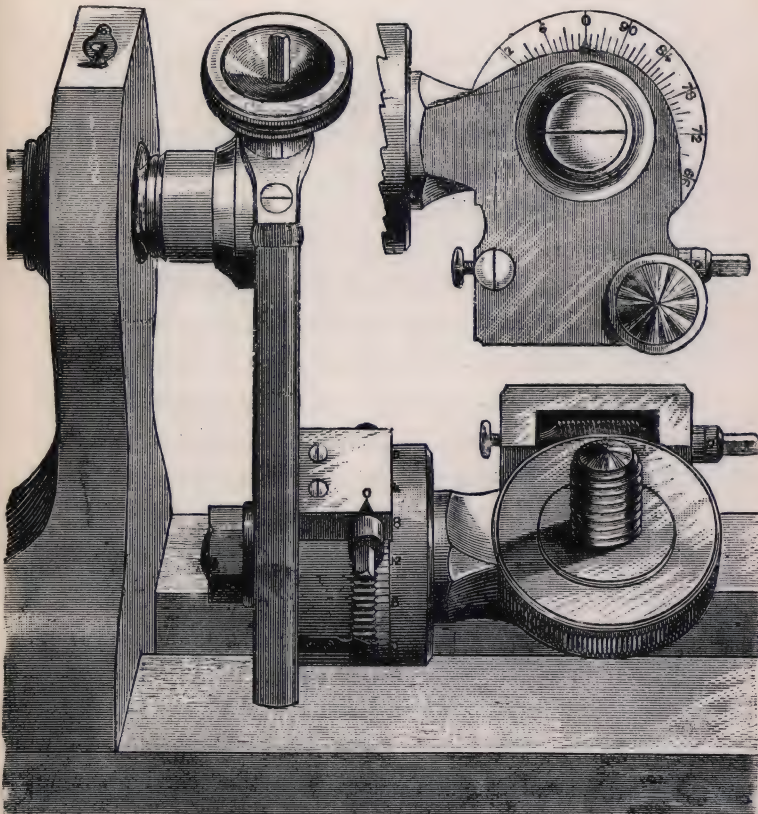
THE DOME OR SPHERICAL CHUCK.

This chuck also forms a very important addition to the apparatus employed for ornamental turning, and by the aid of the following details it will not be found a difficult instrument to manufacture. The chuck illustrated by Fig. 168 is one of the most complete description now made, having improvements which render its manipulation more easy than heretofore. It is composed of a strong oblong metal body with a projecting boss at one end, which is screwed to fit the mandrel-nose; it is then carefully faced with the slide-rest, when set accurately to a right angle, and the sides are filed up parallel, after which the oblong mortise is got out true and square to the body.

A circular metal disc, with a tenon attached to it, is fitted by the latter to slide from end to end of the mortise, one end projecting through the plate, so that it can be fixed at any desired position by a steel nut and washer. On the top of the disc a worm-wheel

with ninety-six teeth is fitted, so that it will revolve. This is achieved by a screw countersunk into the wheel

Fig. 168. Fig. 168*.



and screwing into the lower disc; the worm-wheel is actuated by a tangent-screw working in a metal frame,

fixed also to the lower disc by two screws. On the top of the wheel a third circular plate is fixed, to which is cast, in the solid, the horizontal arm that carries the worm-wheel upon which the work is placed when the chuck is in use; the end of the arm is turned out to fit the external diameter of the tangent-wheel, which is also cut to ninety-six teeth. On one side of the arm a projection is left, so that the tangent-frame can be fitted on an improved plan introduced by the author. It will be seen, perhaps, more clearly, by reference to Fig. 168*, that the screw and frame are made so that the former can be moved in and out of gear; the frame is hinged to the side of the arm by a screw seen on the left-hand side, and a milled head thumb-screw passes through a curved slot in the opposite side; the screw entering the frame, so that when it is required to move the wheel, it is released, and the wheel turned independently; the tangent-screw is then returned to gear and fixed by the thumb-screw.

As an instance of the advantage of this improvement, it may be presumed that it is desired to cut a square base; as one turn of the screw moves the wheel through the space of one tooth, it will require twenty-four complete revolutions to move it one quadrant of its circle; this cannot be deemed anything but a monotonous proceeding, and it is entirely obviated by releasing the screw, and moving the wheel from 0 to

24, 48, and 72 for the respective cuts, fixing the wheel each time by the thumb-screw. To ensure the worm-wheel being as free from vibration as possible, it is held in its place by a screw, under the head of which is fitted a steel washer $1\frac{1}{4}$ in. in diameter; the back of the wheel is divided into ninety-six equal parts and figured at every 6, with a long line at each third division; these are read by a steel point fixed to the arm, the micrometer of the screw being divided into eight equal parts, so that the divisions of the wheel may be subdivided if necessary. Through the body of the chuck a steel screw of ten threads to the inch is fitted, and in consequence of the length of the plain part, and the support derived from its passing through the tenon which forms the nut, there is no necessity for the end of the screw to pass into the metal at the opposite extremity. On the top of the body of the chuck, a metal plate is attached by two screws, the latter bearing against the collar of the main screw, the end of which is filed square to receive a key, and a micrometer with milled head, which is divided into ten equal parts, and figured at each alternate line—0, 2, 4, 6, 8. This division, it may be mentioned, is seldom of much real service in adjusting hemispherical objects, the work being generally reduced approximately to form while revolving on the mandrel-nose, and when transferred to the dome chuck it is adjusted to suit the sphere, without reference to any

particular starting-point or division of the micrometer on the screw.

The worm-wheel attached to the base of the horizontal arm forms an important addition to this chuck, as it enables the work to be moved to an oblique position, by which various compound shapes are formed that cannot be obtained by any other means. The ellipse chuck may be placed on the mandrel-nose, and the dome chuck attached to it; and, for further combinations, the eccentric chuck may be interposed between them.

The following instructions will, it is hoped, assist the amateur to manipulate, and develop, the resources of this chuck. It differs from others in many ways; it holds the work at right angles to the mandrel-nose, and unlike the ellipse and eccentric chucks, it is seldom required to make a complete revolution, its partial rotations being governed by the hand, or placed under control of the worm-wheel and tangent-screw of the segment apparatus, the latter being in most cases preferable.

The work is first turned as nearly as possible to the desired curve, and if from absence of superfluous material extreme accuracy is necessary in its adjustment, it will be expedient to employ a transfer chuck. Of this particular adjunct there are two kinds: a steel chuck is fitted to the wheel of the dome chuck, and

turned out perfectly true to receive the plain end of a spring chuck, and the latter having been turned on the mandrel-nose, will cause the work to assume the same axial truth, when replaced on the dome chuck, with the transfer intervening. Another plan is to have a metal chuck screwed to fit the mandrel, and turned out to fit the stem of the worm-wheel, which is removed from the chuck, while the work is approximately shaped in the transfer, on the mandrel; the wheel is then replaced in the dome chuck, so that the work may receive further decoration. The latter process is slow and is not to be recommended, and the former arrangement is equally correct in its result; the use of either, however, is not always required, as the adjustment of the chuck can be arranged to suit the work.

As an example of comparatively simple work, the body of the pepper-box (Plate 4), which has already been noticed, will serve to demonstrate the action of the chuck for the decoration of spheres, etc. The material was first turned as near as possible to the desired form on the mandrel-nose, on a wood plug, driven firmly into a metal cup chuck, the diameter of the latter being less than that of the material to be operated upon; it was then placed on the dome chuck, while adjusted to stand in a vertical position, as seen in Fig. 168.

When turning the work to the desired form in the

first instance, a minute projection should be left at the centre of the hemisphere, for the purpose of testing the height of the centre, also the lateral position of the same. The slide-rest is then set parallel with the lathe-bearers, with a point, or double-angle tool (Fig. 26), fixed in it; this is very carefully adjusted to the precise height, the point of the tool is then moved laterally by the main screw of the slide-rest until it coincides with the same test point, and to ascertain the accuracy of this, the chuck is moved to a horizontal position by turning the tangent-screw of the segment apparatus forty-five whole turns, or the screw may be released and the chuck moved round by hand, and the screw again moved into gear and fixed by the cam.

Having thus adjusted the tool to the two respective centres, the winch handle of the slide-rest should be removed from the screw to prevent the possibility of its being accidentally shifted; the tangent-screw of the segment apparatus may now be released, and the chuck allowed to hang vertically, which, from its weight, it will do, and, as a series of rotations is required to adjust the arm holding the work, it is not necessary to refix it each time. The steel nut is then loosened, and the horizontal arm moved by the main screw to adjust the work to touch the tool as nearly as possible at all parts of the curve, and if the work has not been turned to a correct sphere it will not be possible for it

to do so, therefore, if the tool is made to cut equally at the circumference and centre, the partial rotation of the chuck will reduce those parts that are not true to a perfect hemisphere, or any portion of the same; the arm is then fixed by the nut at the back.

The drilling instrument now takes the place of the point tool, and has a quarter-hollow drill (Fig. 132) placed in it. This drill, it will be seen, has the curve brought quite to the centre, and is made sharp at the point, so that the reeds, when cut, are close together. It will be found more convenient, in executing work of this kind, to arrange the slide-rest so that the top slide is under control without the use of the lever, both hands being then more at liberty. This is to be highly recommended for all work, but is especially necessary in the present case, as the left hand is required to govern the semi-rotation of the mandrel, while the right hand is fully employed in manipulating the slide-rest, etc.

The tool is then made to penetrate deep enough to bring the top of the reeds up to the shape of the drill, which is ascertained by a series of trials upon the two first cuts; the distance for each being determined by moving the tangent-screw of the chuck the required number of turns, which, at the same time, must be some definite number that will divide into the ninety-six teeth of the wheel—for the pattern under notice three turns of

the screw are made, leaving thirty-two consecutive cuts. Having made all these adjustments, the partial revolution of the chuck is arrested at each point by the pins placed in the side of the worm-wheel of the segment apparatus.

This specimen has been referred to in the details of the universal cutter (Fig 122), as being executed with that instrument, employing a double quarter-hollow tool. As far as the arrangement of the dome chuck is concerned, there is no difference whatever, and if it can be conveniently worked, a fly cutter is preferable to a drill; in some cases the termination of the cut will not admit of the former being used, in consequence of the radius of the cutter causing the frame to come in contact with projections on the work; this must be decided by the operator during the progress of the work, and the instrument which is most suitable for the purpose employed; under any circumstances a drill, or revolving cutter, renders much better work than a fixed tool, which can, however, be employed for a like purpose, but does not cut the incisions so cleanly as the former. The shape of the reeds or ribs produced, will depend upon the form of the tool, and the distance the wheel is moved for each cut. A very fine result is obtained by the wheel receiving sufficient movement to leave an interval of polished surface between each reed; the plain portion can then be further ornamented

by being either pierced seriatim with a round-nosed drill, or studded with pearls, for which purpose a bead-drill (Fig. 130) of the desired size is necessary, and as the width of the space between the reeds gradually diminishes towards the centre, a series of drills of corresponding diminution is necessary to correctly embellish such a form.

Having selected the drills, the wheel of the chuck must be adjusted to the precise half of the distance it was moved for each reed. The first bead, which will be the largest of the series, is then cut near to the circumference, on each intervening space; the dome chuck is then partially rotated and fixed, either by the index-point or the segment wheel, at the desired position; the drill is exchanged for one of rather less dimensions, and by carefully adjusting the distance for each, and using correctly graduated drills, such a pattern is to be made extremely elegant.

It may be mentioned that when it is desired to leave any portion of the hemisphere untouched by the drills or cutters, or free from any decoration whatever, the work must be carefully and accurately turned and highly polished, prior to its being placed on the dome chuck, as it cannot be so finished after the cutting has been executed.

The foregoing remarks have reference to the spherical chuck as employed for the decoration of the

hemisphere only, from which it may be said to derive its name of dome chuck.

It is to be used for the production and ornamentation of many different shapes, such as square or polygonal bases, pedestals, etc., each separate moulding or face of which may be further operated upon by any of the various instruments, as all of them can be employed in conjunction with the chuck.

The dome or hemispherical top of any particular object may be made flatter than the actual hemisphere, by extending the radius of the tool from the axis of the worm-wheel upon which the work is placed; with the tool thus moved, the work will be carried through a portion of the quadrant without touching it, as that part reduced to a flat dome represents a segment of a larger circle; the work for many such-like purposes will require further adjustment in the slide of the chuck.

Fig. 1, Plate 9A, illustrates two distinct applications of the spherical chuck to the decoration of a square and the production of polygonal solid forms, which may contain any number of facets to be moulded in one continuous figure, or incised seriatim, also that different flat surfaces may be panelled out and further decorated. To produce such a result as seen in Fig. 1, the following instructions should be followed: The dome chuck is set accurately to a vertical position, to obtain which it

Plate 9A.

must be tested with a square, the ordinary back-square being most suitable for the purpose; the chuck is thus held by the worm-wheel and tangent-screw of the segment apparatus during the process of cutting the different facets of which the figure is composed.

The object, whether pedestal, box, or other design, is first turned on the mandrel-nose approximately to the desired circular form, after which it is mounted on the dome chuck while in the before-mentioned vertical position, and the transfer chuck intervened to secure its axial truth; the slide-rest is adjusted transversely across the lathe-bed, and the eccentric cutter is employed, with a round-nosed tool, to shape up the facets of the figure—that now under notice, being a square pedestal, first had the body reduced on each surface. The radius of the cutter is extended to cover the space between the base and cornice; the work being adjusted by the screw of the chuck to bring the centre of the facet opposite the axis of the mandrel of the lathe; the cutter is then revolved at speed, and passed over the surface by the screw of the slide-rest, the penetration being adjusted to bring the corners up square and sharp, maintaining the limit of the square as large as the diameter of the cylindrical form will allow. If the height of the pedestal is greater than can be covered by one cut, consequent upon the somewhat limited extension to be obtained in the eccentric cutter, the work

must be raised or lowered by the main screw of the chuck, and the process repeated; the first face reduced, the wheel is turned to each quadrant of the wheel for the remaining three sides. Having cut the body deep enough, the base and capital must be reduced to the same shape, and, as there is a great deal less depth, the radius of the tool in the eccentric cutter should be reduced to suit it, and the work raised or lowered by the screw of the chuck. The two projections thus roughly shaped may be considered ready to receive the mouldings. This may be done either with separate tools in the eccentric cutter, by the moulding tools selected from the series 82 to 93, or by a moulding-drill. If the latter is employed, the work must be brought to closer contact for the succeeding cuts required to complete the figure, by again raising or lowering the arm of the chuck, but when the eccentric cutter is used, this may be avoided by increased radius being given to the tool. The base and capital of Fig. 1 were cut at the same time by a moulding tool in the eccentric cutter. Mouldings of this kind are also cut with the tool revolving horizontally in the universal cutter, Fig. 122, and the radius of the tool adjusted to best suit the material and its various proportions. In some cases this is perhaps the most convenient means to adopt, the frame of the instrument, from its construction, being less likely to come in contact with other

projections on the material which may be in close proximity to that under treatment.

It is, when cutting mouldings of this nature, that mitre at the corners, that the accuracy of the vertical adjustment of the chuck is certified, any error in this point being fatal to the production of excellent work, and consequent finish. To ensure its being correct, it is better to test it each time the chuck has been partially rotated for any specific purpose, and when the tangent-screw is replaced in the worm-wheel of the segment apparatus, this can be quickly done should it be necessary.

If it is desired to further decorate the four facets of a square pedestal, each one may be so embellished with a variety of patterns, any of those to be produced by the eccentric cutter being available for the purpose. The work is placed in position by the vertical movement derived from the main screw of the chuck, and to produce the pattern illustrated by Fig. 1, the tool in the eccentric cutter is first adjusted to the centre of the facet by the lateral movement of the slide-rest, and the screw of the chuck in the vertical line; the adjusting index is placed in the 96 division, the eccentric cutter extended to a radius of $\frac{2}{10}$, and the slide-rest moved $\frac{2}{10}$ forward, then cut round at every twelve holes, a double-angle tool of 45° being employed.

A second side of this figure, it will be seen, has been

cut in a different way. The same moulding tool that cut the base and cornice is employed, the eccentricity being reduced to cut the recess to the desired width. The dome chuck is set to the horizontal position by moving the worm-wheel of segment forty-five turns of the tangent-screw, the slide-rest remaining in the same position. The fluting-stops are fixed to arrest the traverse on each side of the centre. The cutter is then revolved at a high speed and traversed gently through the length.

If it is desired to cut out a panel with square terminals, the work must be raised and lowered for the two ends, and the sides cut with an even traverse of the work by the screw of the chuck when set vertically. This description of panel may be cut also with a number of consecutive cuts seriatim, and this is a kind of decoration where the divisions on the micrometer on the main screw of the chuck are of service. For instance, if the ends have been cut, say at every one or two turns of the screw of the slide-rest, the sides should be cut in equal proportions, therefore the vertical movement must coincide with that of the slide-rest, the length and breadth having been arranged to receive so many cuts each way.

For works of extra size it is preferable for many reasons to build up the subject of separate pieces,

especially when composed of ivory, as the reduction of the circular form to a square pedestal involves the loss of a considerable amount of material.

Fig. 2 illustrates a still further and distinct mode of decoration, and consists of a reeded spherical top, with the same figure carried through the diameter of the cylinder. This specimen represents a match-box, and may be made both useful and ornamental. The box is first turned out inside, and the lid fitted; it is then turned to the desired proportions while on the mandrel-nose; then mounted on the dome chuck, in the transfer; while the dome is adjusted by the slide of the chuck, and the reeds on the curved top first cut; the slide-rest being set parallel with the lathe-bed; this requires three turns of the tangent-screw for each individual penetration, the universal cutter (Fig. 122), turned to 90° to cut vertically, being employed with a double quarter-hollow tool (Fig. 98) $\frac{16}{100}$ in. wide. When the top is thus cut, the slide-rest is set at right angles to the bed, the dome chuck set to the horizontal position, and the universal cutter turned to zero, which will bring it to the position in which the tool revolves horizontally. The cut being carried throughout the entire length of the work, it is not necessary to use the fluting-stops, but the penetration of the tool must be very carefully adjusted to agree with the incisions already cut on the dome. This is not by any means a difficult class of

work, but at the same time it requires considerable care.

The moulding at the base of this figure, it will be seen, has been worked up in a different way, by cutters varying in form and the manner in which they are applied; the manipulation of the chuck also receiving fresh treatment. The square is first roughly shaped, having the sides removed by a saw, it is then faced over on one side, and a hole about $\frac{3}{4}$ in. in diameter turned in the centre; by this hole it is fitted to a short plug or chuck, so that the surface of the work will bear against its face, which must be less in diameter than the sides of the square when finished, it is then held by glue to ensure its maintaining its position, and the top turned to the desired thickness.

The work is then mounted on the dome chuck, which is accurately set to the vertical position, the slide-rest is set at right angles to the lathe-head, and the eccentric cutter fixed in it with a round-nosed tool; the radius of the tool is extended just to cover the width of the base, and the four sides are cut to the same depth, which is decided by the stop-screw of the top slide. Having cut the four sides, the tool is changed for one with a square end about $\frac{10}{100}$ in. wide, the work lowered so that the material may be further recessed, leaving the lower extremity $\frac{2}{10}$ deep. It is then again lowered by the slide of the chuck, and

recessed at the top to remove the material, so that the bead-tool, which is next used, shall not have more to do than is absolutely necessary.

The universal cutter, Fig. 122, now replaces the eccentric cutter, and is arranged for the tool to revolve horizontally; a bead-tool, Fig. 105, of suitable size is then employed to cut the moulding, and this, it will be observed, is a more distinct figure than when cut with a quarter-hollow tool. For many types of work this may be used with considerable advantage; a round-nosed tool is then used to cut the concave curve at the top, a square fillet intervening between it and the bead. The base is then decorated with a series of consecutive cuts, which particular class of work forms another interesting feature of the chuck, and these may be executed in two ways; the simplest, however, is the following, and that by which the specimen under notice was produced.

The chuck still remains in the vertical position, and the universal cutter is turned to 90° to cut vertically, the slide-rest in the same position; the tool is exchanged for a double-quarter hollow (Fig. 98) of suitable size; the point of this tool is then set accurately to the centre of the square, by the lateral traverse of the slide, the micrometer at the same time at zero; the work is then spaced out by this means to receive so many cuts on each side of the centre. Having arranged this to suit

the work, the first cut is made, the tool revolving at a high speed, and the work passed up and down through the space to be cut, by the main screw of the chuck, for which purpose the nut at the back is released to allow the horizontal arm to move without undue freedom or shake; in the base of the match-box, there are twelve consecutive cuts in each facet; the depth is ascertained in the usual way by trial cuts, and the tool moved laterally $\frac{2}{10}$, or two turns of the slide-rest screw.

The incisions may be cut in a number of different designs, by having spaces left between each, to afterwards receive another style of ornament; they may be produced also by moulding-drills; in fact there is practically no end to the variety of elegant decoration to be obtained by varying the tools used.

The same result may be produced in the following manner:—The dome chuck is mounted upon the rectilinear chuck, which is adjusted to stand vertically when on the mandrel-nose, in which position it is securely held by the tangent-screw and worm-wheel of the segment apparatus; the dome chuck is then set accurately to the horizontal position by the adjustment of the worm-wheel of the rectilinear chuck; the universal cutter being again turned to zero for the tool to cut horizontally.

The tool is set to the centre of the square as before, but in this case the work is spaced out by the movement

of the slide of the rectilinear chuck, which, to obtain the same distance, would require two turns of its main screw, while the slide-rest screw is used to pass the tool through the material. Although for many classes of work the interposition of the rectilinear and ellipse chucks is absolutely necessary, it is not so in the case of the figure under notice, but at the same time it serves to point out the action of the chuck, should it be required for similar works.

The chuck illustrated by Figs. 168 and 168*, is further improved by the length of the horizontal arm being extended, as it now admits of a square base six inches across the corner being revolved on the wheel; and although the extra length tends theoretically to vibration, it has no existence in practice, when the chuck is substantially and well made.

Fig. 3 demonstrates the mode of employing the dome chuck to decorate the concave curve, and this, of increased diameter. The form is first approximately turned by hand, also the convex curve forming the rim; it is then mounted on the dome chuck, and the tool allowed to follow a curve of the diameter contained in the figure; the chuck that holds the work must be as shallow as possible, so that the axis of the work may be placed as far as possible from the centre of the lathe mandrel, away from the operator. The chuck is then set to the horizontal position, and fixed by the worm-wheel

of the segment apparatus, the slide-rest parallel with the lathe-bearer, and the universal cutter (Fig. 122) placed so that the tool revolves vertically, a double quarter-hollow tool (Fig. 95) being used.

The tool must be extended to a radius of $\frac{9}{10}$, so that the full depth of the curve may be cut without the frame reaching the edge of the work. The point of the tool is then set accurately by the movement of the slide-rest screw, to agree with the test centre, which, when first prepared, should be left on the work for this purpose. The horizontal arm is then adjusted along the body of the chuck until the tool will pass as nearly as possible over the curve, the two usual trial cuts are then made to decide the depth. As there are forty-eight reeds in the specimen illustrated, the worm-wheel of the chuck is moved two divisions for each succeeding cut.

The partial rotation of the mandrel is arrested at the centre by one of the pins placed in the side of the worm-wheel, and, in arranging this, the radius of the tool must be considered—it should just cut out at the centre; therefore when the radius of the tool is allowed for, the dome chuck will not assume the exact horizontal position each time the tool reaches the centre. The tool passing out at the diameter, it is not necessary to employ the second stop-pin, except to prevent the chuck from completing the revolution,

should the hand be released. For work of a very bold character, it is always advisable to rotate the mandrel by the tangent-screw, thus preventing such an occurrence. A corresponding result may be obtained by employing the drilling instrument with a quarter-hollow drill (Fig. 132), but a revolving cutter is the better mode to adopt.

In consequence of the dome chuck requiring to be extended so far from the centre on the one side to trace the concave curve, the convex curve forming the outer rim will necessitate an equally distant adjustment on the opposite side, and from the limited movement of the horizontal arm in this direction it is not possible to trace a curve of so large a diameter without interposing a deep transfer chuck to carry the work nearer towards the operator. The radius of the tool may now be reduced, but it must be adjusted laterally by the slide-rest screw most carefully, so that the tool will follow precisely the same course as that previously cut on the concave curve. When these adjustments are made, the same movement of the worm-wheel of the chuck is required, and as the cut is carried out in each direction, the segment-stop will not be required, except to prevent the entire revolutiou of the chuck, as above described.

Fig. 4. To reproduce this example, the material is first shaped by hand-turning, after which it is mounted

on the dome chuck when set vertically on the mandrel, the slide-rest set parallel with the bed of the lathe, and the universal cutter (Fig. 122) or the ordinary vertical cutter (Fig. 94) placed in it, with a broad double-angle tool of 50° set to a radius of $\frac{5}{10}$; the tool is set accurately to the centre, for which purpose the usual test-point is left on the work, and the depth of cut determined. To adjust the latter, the cutter is placed over the concave curve, and the work moved up to it by the main screw of the dome chuck, and when deep enough, the tool is withdrawn by the guide-screw of the top slide; the worm-wheel of the chuck is then moved by two turns of the tangent-screw, and the second cut made; by these two trial cuts, the penetration is adjusted till the edges are made quite sharp; each consecutive incision is then made by the movement of the top slide, arrested by the stop-screw, the horizontal arm being fixed when the depth is determined.

Having cut all round in this way, the tool is withdrawn to the edge of the material, that it may cut in precisely the same radial line, to produce the points; and here again the depth is obtained by the two first cuts, and when so arranged, the nut of the horizontal arm is loosened so that it can be moved by the screw, up and down, and by it the work is moved past the tool while the latter revolves at a high speed, the result

being as seen in the plate, a series of angular points each accurately placed as a terminal to the reeds cut on the concave curve.

The chuck which holds the work is now placed in a deep transfer to extend the convex curve further from the axis of the lathe mandrel, and as the particular shape of the tazza is required to be a portion of a large circle, the work is adjusted by the screw of the chuck to the position required, the same tool being set to follow accurately the figure cut on the previous curve; one stop-pin should be placed in the worm-wheel of the segment apparatus to prevent the cut passing the centre, the second is also used to protect the points already cut from accidental damage, if the mandrel should be turned beyond the required distance, which, especially under the guidance of the hand only, it is likely to be. Many very beautiful decorations may be placed on different curves, by a careful selection of the tools employed.

CHAPTER XI.

ELECTROTYPING.

The enthusiastic amateur who has succeeded in producing some of the beautifully artistic work of which the lathe is capable, will be pleased, and agreeably surprised, by the charming results that can be obtained by reproducing these in *copper*, by electro deposition. The process is at once simple and inexpensive, and by a little modification can be used to give reproductions, either precisely similar to the original turned work, or ones in which the reliefs and depressions are reversed. As the latter are very effective, we shall describe the method of obtaining these first.

The operator will provide himself with two or three good "dry cells." Those known as "British" will be found most suitable for this purpose. A convenient size measures 6 in. by 2 in. He will also require a saturated solution of sulphate of copper (blue vitriol), which he can make up by pouring one quart of boiling water on one pound of sulphate of copper, stirring

frequently with a stick or glass rod until cold. The solution should be made up in a glazed earthen vessel. When quite cold, about one and a half fluid ounces of oil of vitriol should be added to the blue fluid, in a fine stream, with constant stirring. The addition of the oil of vitriol will cause the solution to get hot. It must be allowed to cool, when it may be placed in a stoppered bottle, ready for use. Several discs of thin sheet copper (about $\frac{1}{16}$ in. thick) of varying diameters, according to the size of the work to be reproduced, will also be needed, and to the edge of each of these (which are called "anodes") is to be attached a wire by drilling a little hole near the edge of each disc and inserting therein one end of a 10-in. length of No. 16 copper wire, and burring it over the plate by hammering. This makes good contact, without soldering, which is to be avoided. The next requisite is a rather deep, flat-bottomed, circular, well-glazed earthenware dish. A soup-plate will answer very well, unless the objects to be copied are very large; in which case one of the square white earthen dishes, used by photographers wherein to wash their prints, may be used. Two or three yards of No. 18 or No. 20 bare copper wire will also be required for the purpose of connecting up the wooden ornamental turned work to the negative pole of the dry cell.

Being provided with the above necessaries, the

operator selects the turned work which he desires to reproduce in copper, and brushes over the worked surface with a paste made of good fine plumbago (blacklead) and a little water. The brush made use of must not be so hard as to mark or in any wise deface the delicate tracery produced by the lathe tools, but, on the other hand, it must be sufficiently firm to enable the operator to get up a brilliant metallic looking surface like that of a well-polished stove. For convenience of future reference we will call this blackleaded surface "the front" of the mould. The purpose of performing this operation is to render the wood, which would not otherwise conduct electricity, conductive on this surface. It must be borne in mind that wherever the blacklead has been applied *there* will the copper be deposited. Hence, to prevent waste of battery power, copper, and time, care must be taken not to carry the blackleading too far up the sides of the work. A little way up it must reach, so as to enable good contact to be made with the wire, which will afterwards serve to connect it to the negative pole of the dry cell. The best way to effect this is to take a strip of paper, and roll it tightly round the sides of the work, leaving about $\frac{1}{4}$ in. bare all round near the front of the mould. Holding this tightly in the left hand it will be easy to blacklead and polish the edge as well as the front without encroaching too far up the sides. When this has been

satisfactorily effected, the paper strip, which served as a guard, can be removed. Now, taking a piece of the No. 18 or No. 20 bare copper, and gripping one end in the vice, he will wind it two or three times round the blackleaded edge of the work, so as to grip it firmly and make good electrical contact with the blacklead under it. The extremities of this wire are brought together and twisted tightly, so that the coils may not loosen. The wire should now be cut off at a distance of about 10 in. from the work, and bent upwards at right angles to the front of the mould. An anode is now selected, having a diameter as nearly as possible that of the front of the mould. (This wire, as far as it will be immersed in the copper sulphate solution, must be painted over with a little Brunswick black, otherwise it will be eaten through by the solution.) The other end of this wire must then be clamped under the terminal affixed to the carbon (or positive) pole of the dry cell, and then bent twice at right angles, in such a manner that the anode can lie flat at the bottom of the dish, which must be placed near the dry cell. The dish should now be filled to a height of about 1 in. to $1\frac{1}{4}$ in. from the bottom, with the copper sulphate solution prepared as directed. The work to be copied is now attached, by its slinging wire, to the zinc (or negative) pole of the dry cell, and the wire so bent that the front of the mould is immersed in the solution as far as

the wire binding extends, or, say, for a depth of about $\frac{1}{4}$ in. It should lie perfectly horizontal, facing, but *not touching*, the anode, at a distance of about $\frac{3}{4}$ in. to 1 in. from *its* surface. In immersing the mould, care must be taken to avoid air bubbles, and this can be done by letting down the front of the mould, somewhat tilted, so as to allow any air bubbles to escape; the wire can afterwards be straightened to cause it to lie horizontally.

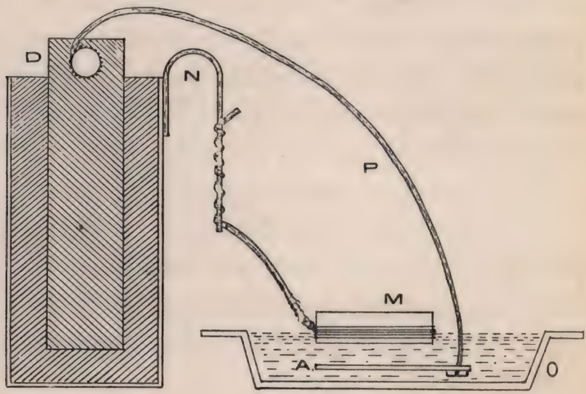


Fig. 168**.—D, Dry cell; P, Wire from Positive terminal; N, Wire from Negative terminal; M, Mould; A, Anode; O, Dish.

Great care must be taken that *good metallic contact* is made between the two wires and their respective dry cell terminals, and also that no chance contact occurs, either between these two wires on the one hand, or between the mould and the anode on the other. After

thus connecting up, the front of the mould should be allowed to remain in the solution for about fifteen minutes. It should then be examined in order to judge of the success of the work.

If the binding wire shows that it has received a rosy-pink deposit, beginning to extend to the edge and creeping round to the front of the mould, all is going well—the current is of the right strength; and if the mould be carefully replaced in the solution, the terminal contacts being maintained tight and good, it will be found that after ten or twelve hours' immersion the entire surface of the mould will have received a delicate coating of copper. To get a layer $\frac{1}{16}$ in. thick it may be needful to continue the operation for three or even four days, or even to replace the dry cell by a fresh one, according to the size of the mould. But if on examination it is found that the surface of the binding wire and of the front of the mould are coated with a ruddy brownish mud, tending to fall to the bottom of the dish, and especially if bubbles of gas form on and round about the mould it is a sign that the current is *too strong*. In this case it will be necessary to remove the anode further away from the front of the work, or even to insert a "resistance" in the shape of a foot or two of No. 36 iron wire between the anode and the carbon terminal of the dry cell. When it is considered that

the copper deposited has attained sufficient thickness the mould should be removed from the sulphate of copper solution, the wire detached from the dry cell, and the mould washed for some time in a stream of running water; after which it should be slung up by its wire to dry thoroughly in a warm place. When the work is quite dry the binding wire is untwisted, and the wire carefully unwound from round the edge of the work. If the copper deposit is very thick at these points, it will be advisable to file it down cautiously all round, so as to avoid breaking away any of the copper deposited on the front. Having thus filed away any copper that may have extended round the edges of the work, the front of the mould should be held for a few seconds before a clear fire so as to warm the copper coating. This will cause it to expand slightly, after which, by cautiously pushing with the fingers from the back of the mould, the copper coating or "electrotype" can be easily detached. It may then be washed and brushed up with a soft nail-brush and soap and water, dried and mounted on velvet; or it may be "bronzed" with blacklead. The work or mould, if soiled with blacklead, may be cleaned with a soft tooth-brush moistened with benzine. It may be necessary after this to brush up with soap and water, using a fresh clean brush.

When it is desired to produce a facsimile of the ornamental work, a trifling modification must be made in the manipulation. This consists essentially in preparing, first, a wax mould or cast from the original turned work, from which mould the copper electrotype is produced. To this end take a strip of paper long enough to make four or five turns round the sides of the object to be copied. This must be bound round the edge, so as to extend up above the face of the work to a height of nearly half an inch, and tied tightly round the sides. The whole should now be laid on a flat table, face upwards. Sufficient good beeswax to cover the face of the work to a depth of about $\frac{3}{8}$ in. is now melted in a perfectly clean pipkin or ladle. The surface of the work and the inside of paper binder are now heavily breathed upon so as to prevent the wax adhering, when the melted wax is immediately poured in to a depth, as we have said, of about $\frac{3}{8}$ in. The mould should now be allowed to stand for an hour or two to set and harden thoroughly. The paper binder is then removed, the wax mould pulled off, and three or four turns of No. 20 wire bound round the edge, the surface and the edge of the mould carefully blackleaded with a very soft camel-hair brush. It will not be advisable to wet the blacklead, but, using fine powder, breathing on the mould will suffice to render the surface sufficiently

adhesive to take a good polish. The blackleaded mould is now to be treated precisely as recommended for the wooden original. At Fig. 168** is shown sectionally the proper position and connections of dry cell, wire to anode, depositing dish, mould, and wire from mould to negative pole of cell.

END OF VOL. II.

PRINTED BY WILLIAM CLOWES AND SONS, LIMITED, LONDON AND BECCLES.

Photographic Studios and Dark Rooms. With 180 Illustrations.
Contents.—Planning Studios. Building Studios. Portable and Temporary Studios. Studios Improvised from Greenhouses, Dwelling Rooms, etc. Lighting of Studios. Backgrounds. Scenic Accessories. Dark-Rooms. Portable Dark-Rooms. Dark-Room Fittings. Portable Dark Tent. Index.

Motor Bicycle Building. With 137 Illustrations and Diagrams.
Contents.—Frame for Motor Bicycle. Patterns for Frame Castings. Building Frame from Castings. Making 3½ H. P. Petrol Motor. Spray Carburettor for 3½ H. P. Motor. Ignition Coils for Motor Cycles. Light-weight Petrol Motor for Attachment to Roadster Bicycle. Spray Carburettor for Light-weight Motor. Index.

Rustic Carpentry. With 172 Illustrations.
Contents.—Light Rustic Work, Flower Stands, Vases, etc. Tables, Chairs and Seats. Gates and Fences. Rosery Work, Porch, Swing Canopy Aviary, Footbridges, Verandahs, Tool Houses, Garden Shelters, etc. Summer Houses, Dovecot. Index.

Pumps and Rams: Their Action and Construction. With 171 Illustrations.
Contents.—Suction Pumps and Lift Pumps. Making Simple Suction Pumps, Pump Cup Leathers, Pump Valves, Ram or Plunger Pumps. Making Bucket and Plunger Pump. Construction of Plumbers' Force Pump, Wooden Pumps, Small Pumps for Special Purposes, Centrifugal Pumps, Air Lift, Mammoth, and Pulsometer Pumps, Hydraulic Rams. Index.

Domestic Jobbing. With 107 Illustrations.
Contents.—Cutlery Grinding, Sharpening and Repairing. Simple Soldering and Brazing. China Riveting and Repairing. Chair Caning, Furniture Repairing, Glazing Windows, Umbrella Making and Repairing. Index.

Tinplate Work. With 280 Illustrations and Diagrams.
Contents.—Tinmen's Tools, Appliances and Materials. Elementary Examples in Tinplate. Hollowing Tinplate. Simple Round Articles in Tinplate. Saucepan Making. Square and Oval Kettle Making. Oil Cooking Stove. Set of Workshop Oil Cans. Fancy Paste Cutters. Lamps and Lanterns. Index.

Other Volumes in Preparation.

DAVID McKAY, Publisher, Washington Square, Philadelphia.

Practical Handrailing. With 144 Illustrations.

Contents.—Principles of Handrailing. Definition of Terms. Geometrical Drawing. Simple Handrails. Wreathed Handrails on the Cylindrical System. The Uses of Models. Obtaining Tangents and Bevels. Face Moulds: their Construction and Use. Twisting the Wreath. Completing the Handrail. Orthogonal or Right-angle System of Setting Wreathed Handrails. Handrails for Stone Stairs. Setting out Scrolls for Handrails. Setting out Moulded Caps. Intersecting Handrails without Basements. Index.

Practical Brickwork. With 368 Illustrations.

Contents.—English and Flemish Bonds. Garden and Boundary Walls. Bonds for Square Angles. Excavations, Foundations, and Footings. Junctions of Cross Walls. Reveals, Piers. Angles and other Bonds. Jointing and Pointing. Damp-proof Courses and Construction. Hollow or Cavity Walls. Chimneys and Fireplaces. Gauged Work and Arches. Niches and Domes. Oriel Windows.

Practical Painters' Work. With Numerous Illustrations.

Contents.—Objects, Principles and Processes of Painting. Painters' Tools and Appliances. Materials used by Painters. Paint Mixing. Preparing Surfaces for Painting, Painting Woodwork, Painting Ironwork, Painting Stucco or Plaster; Distempering and Whitewashing Color Combination. House Painting. Varnish and Varnishing. Stains and Staining. Estimating and Measuring Painters' Work. Index.

Textile Fabrics and Their Preparation for Dyeing. With Numerous Illustrations.

Contents.—Cotton. Flax, Jute, and China Grass. Wool. Silk. Cotton Bleaching. Linen Bleaching. Mercerising. Wool Scouring and Bleaching, Scouring and Bleaching Silk. Water. About Dyeing. Index.

Coloring Matters for Dyeing Textiles. With Numerous Illustrations.

Contents.—Indigo Coloring Matters. Logwood Coloring Matters. Natural Red and Yellow Coloring Matters. Aniline Coloring Matters. Azo Coloring Matters. Anthracene Coloring Matters. Chrome Yellow, Iron Buff, Manganese Brown, Prussian Blue, Method of Devising Experiments in Dyeing. Estimation of the Value of Coloring Matters. Index.

Sanitary Construction in Building. With 131 Illustrations.

Contents.—Introductory. Soils, Subsoils, and Sites. Materials of Construction. Footings, Foundations, and Damp-proof Courses. Stability of Walls. Roofs. Floors, Hearths, and Staircases. Air Space and Ventilation. A Typical Dwelling. Index.

Iron: Its Sources, Properties, and Manufacture. With Numerous Illustrations.

Contents.—Introductory: Terms Explained. Refractory Materials, Crucibles, etc. Ores of Iron. Metallurgical Chemistry of Iron. Cast Iron or Pig Iron. Preparation of the Ores. Changes in the Blast Furnace. Blast Furnace. Air Supply. Blowing Engines Working the Blast Furnace. By-products. Malleable or Wrought Iron. Production of Malleable Iron. Preparation of Malleable Iron in Open Hearths. Puddling. Refining Pig Iron and Dry Puddling. Forge Machinery. Iron-rolling Mill. Index.

Steel: Its Varieties, Properties, and Manufacture. With 132 Engravings and Diagrams. By WILLIAM HENRY GREENWOOD. Revised and Rewritten by A. HUMBOLDT SEXTON.

Contents.—Steel: Its Properties and Manufacture. The Bessemer Process. The Basic Bessemer Process. Modifications of the Bessemer Process. Gas Producers and the Siemens Furnace. The Siemens or Open-hearth Steel Process. The Basic Open-hearth Process. Modifications of the Open-hearth Process. Steel Works Appliances. The Cementation and Monor Steel Processes. Casting Steel. Forging and Rolling Steel. Microscopic Structure of Steel. Heat Treatment of Steel. Theory of Steel. Testing Steel. Specifications of Steel for Various Purposes. Alloy Steels. Index.

Other New Volumes in Preparation.

DAVID McKAY, Publisher, Washington Square, Philadelphia.